POWER PLANT ENGINEERING

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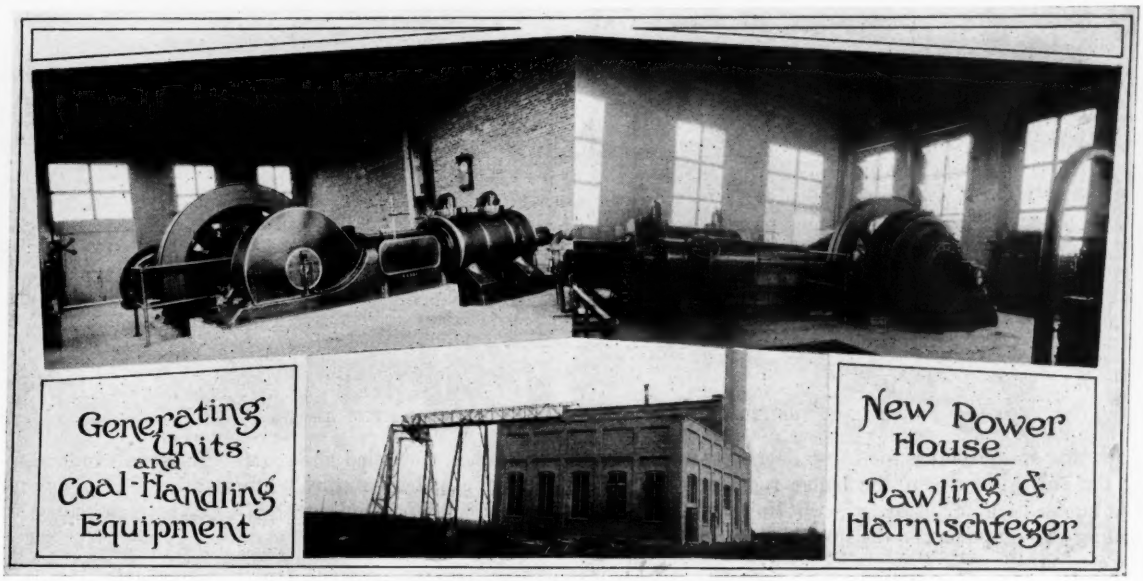
Meeting Increasing Industrial Demands

MONORAIL COAL AND ASH HANDLING EQUIPMENT AND UNIQUE ELECTRIC DISTRIBUTION SYSTEM FEATURES OF NEW PAWLING & HARNISCHFEGER INSTALLATION

INDUSTRIAL DEVELOPMENT OF COMMUNITIES indicates a tendency of manufacturing establishments to seek urban locations and thereby not only avoid the congested conditions so prevalent in our large cities, the high rents and rates of taxation and the more or less limited transportation facilities found there, but also to secure for employes improved living, housing and working conditions. It was undoubtedly for these reasons and the urgent need for expansion which prompted the Pawling & Harnischfeger Co., after being located many years in the heart of Milwaukee's south side manufacturing district, to move its plant to West Allis, just east of the grounds of the National Soldiers' Home.



Originally the Pawling & Harnischfeger Co. specialized in the manufacture of electric traveling cranes, but with the growth of the institution new lines were added until at the present time its products, in addition to these cranes, consist of all types of monorail hoists, single line grab buckets, horizontal drilling and boring machines, trench excavators, tamping machines, back fillers and drag line excavators. And as a consequence new shops were added and extensions made to existing ones. Naturally these changes added to the demands upon the power generating equipment until a year or two ago, when the ultimate capacity was reached and the construction of a new plant became imperative. Accordingly, this was built, and while the initial steps were taken many months before, the electric generating units were not placed in operation until the first day of April of the present year.

As shown in the accompanying illustrations, the building housing the steam and power generating equipment is a single story, fireproof structure of steel, concrete and brick, and by means of a 13-in. party wall is

divided into two sections, one of which is the boiler room, while the other, that extending to the west, is the engine room; a basement with 11-ft. head room provides ample space for the forced draft apparatus, a portion of the water softening equipment, some of the pumps and the power-house supply stores.

The structure has an overall length of 90 ft. 2 in., a width of 66 ft. 10 in. and except for a 14½-ft. wide section above the coal bunkers, a height of 50 ft. 5 in. from the bottom of the foundation footings to the side wall coping. Three-inch back tiling with 18-in. spacings is employed for roofing, the frame of which above the boiler room is carried by transverse 12-in. I beams and that over the engine room by 8-in. channels supported by structural steel trusses.

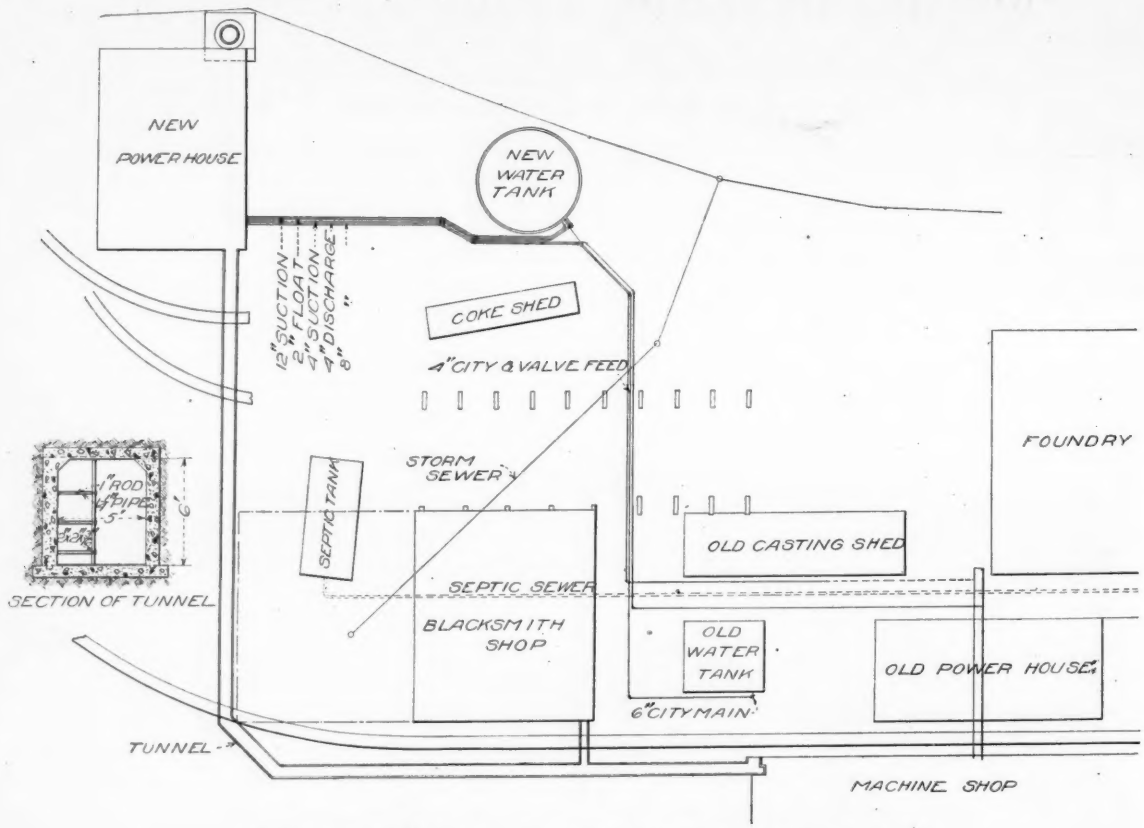


FIG. 2. GENERAL LAYOUT OF PAWLING & HARNISCHFEGER WORKS

Resting on individual footings of concrete and extending the entire length of the boiler room are two rows of columns each made up of two 15-in. channels and forming the supports for the bunkers, the monorail coal conveyor track and its enclosing housing. The bunkers, which have a capacity of 450 tons, are hyperbolic in section and are built up of steel plates with a 3-in. concrete lining.

All foundations extend to a depth of about 12.5 ft. below the ground level and except in the case of those for the boiler settings are independent of wall footings. Although one of the engines is comparatively small and will undoubtedly be replaced by another unit of greater capacity as soon as load conditions demand such a change, the two engine foundations are practically of like size and form. Each has an overall length of about 30 ft. 9 in. and a width of approximately 21 ft., and in order to facilitate the installation of the anchor bolts pockets in the sides of the foundations place the lower nuts and bearing plates within ready reach; to insure the proper alinement of these bolts with the engine bed plate holes they are passed through 6-in. stove pipe cast into the foundation.

With the equipment now installed the capacity of the plant may be more than doubled without rendering necessary any building changes, but should ultimate demands be such as to require even greater capacity the building may, with but little trouble, be extended to the south.

The walls, as may be seen in the accompanying illustrations, are paneled and fitted with large windows, providing excellent natural illumination throughout the hours of daylight in both boiler and engine rooms.

Steam Generating Equipment

Although, as in the engine room, foundations have been installed for future units, the steam generating equipment at the present time consists of but one battery of two 300-hp. Badenhausen water-tube boilers equipped with interheaters, superheaters and Riley stokers. Steam is normally generated at a pressure of 150 lb. gage and before being delivered to the main heater is superheated 125 deg. F.

Forced draft is employed. This is secured by means of a 6-ft. Sturtevant fan of steel plate construction,

design No. 2, located in the basement of the boiler room and operated by one of two 6 by 6-in. vertical steam engines, the speeds of which are dependent upon the pressure of the steam, regulation being accomplished by

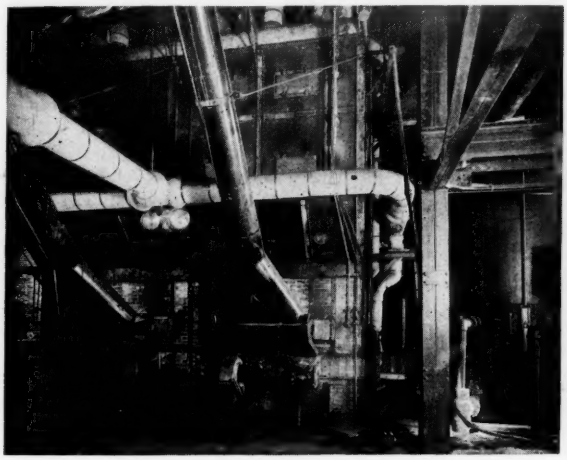


FIG. 3. VIEW IN BOILER ROOM

means of a Ruggles-Klingemann pressure regulator connected to the supply engine lines. The engines are also of Sturtevant make, and as one is placed on either side of the fan and connected to its shaft through independent couplings, they may be operated alternately as desired or required.

The outlet of the fan, which has dimensions of 2 ft. 9.5 in. by 2 ft. 6.5 in., connects to the foundation air pits

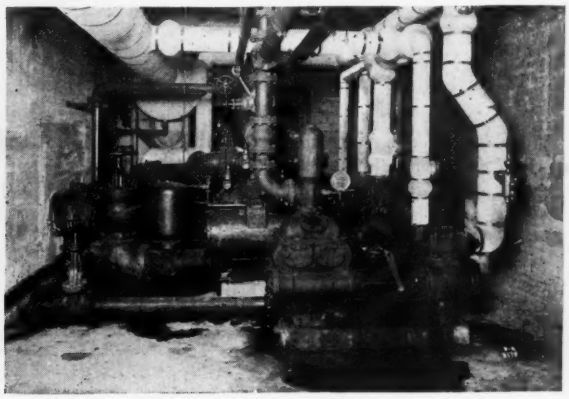


FIG. 4. PUMP ROOM WITH TUNNEL ENTRANCE AT REAR

through a Y duct, each branch of which is 24 in. in diameter and is fitted with an individual damper; the main section of the duct is 3 ft. in diameter and like the branch connections is made up of number 16 gage black iron.

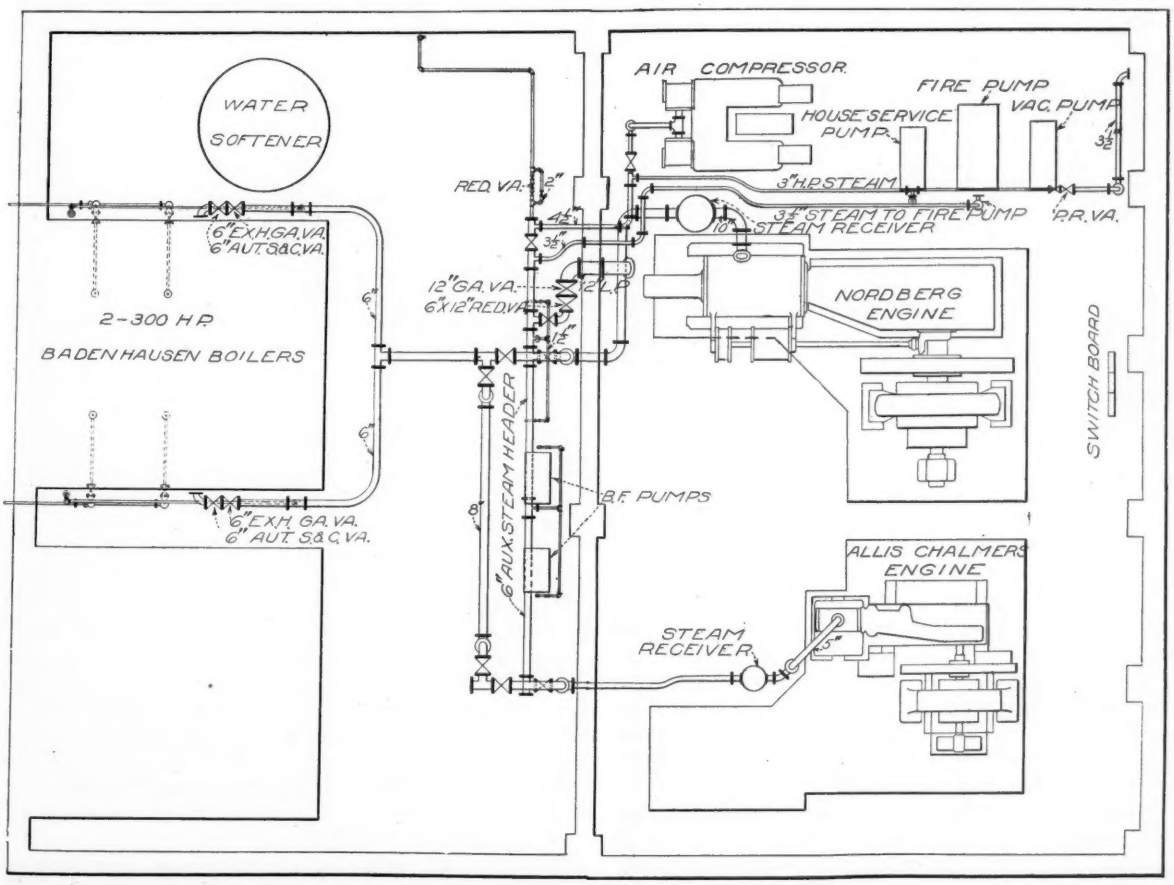


FIG. 5. PLAN OF PLANT AND LAYOUT OF HIGH-PRESSURE PIPING

Coal coming from the overhead bunkers is fed to the stoker hoppers through individual spouts, the feed being controlled by means of 18-in. chain-operated gate valves. The spouts, 16 in. in diameter, are made of number 12 gage steel and in order to insure proper distribution of the coal to the hoppers each is fitted with a removable fan-shaped discharge having outlet dimensions of 4 ft. 9 in. by 12 in.

Coal and ashes are handled by a monorail conveyor, the structural work for which is shown in detail in the front page illustration and Fig. 6. Coal is delivered to the plant in cars run onto a spur of the C., M. & St. P. Ry. and is removed from these by a 1.5-yd. clam shell bucket and deposited either into a 650-ton outdoor storage pit or the bunkers, as operating conditions and the supply on hand may demand.

Ashes discharged by the stokers are caused to fall into a pit built integral with the boiler foundations and of the form shown in Fig. 6; thence they are removed by hand and raked into small four-wheel cars which after being filled are run into an outside pit, raised by means of the conveyor to the ground level and placed upon a track leading to nearby dump grounds.

Natural draft, which is depended upon during light load periods and such times as when the fan in the basement of the boiler room may be inoperative, is provided by a reinforced concrete stack having a total height of 182 ft. and an external diameter of 10 ft. at the base and 6 ft. 6 in. at the top; the thickness of the walls tapers from 10⅝ to 5 in.

Connecting the last passes of the boilers with the stack is a breeching built up of plates of No. 10 U. S. gage steel sheeting reinforced by 2.5 by 3 by ¼-in. angles except at the corners at which points 2.5 by 2.5 by 3/16-in. angles are employed. The section of the breeching at the smaller end is 6.5 by 4.5 ft., while at the entrance to the stack the overall dimensions are 3 ft. 10 in. by 9.5 ft.; each boiler connection has an overall length of 7 ft. 3¾ in. and a width of 21 in., the ends being rounded to facilitate construction and avoid the use of bracing and reinforcing. Near the smaller end is a 24 by 10-in. clean out door.

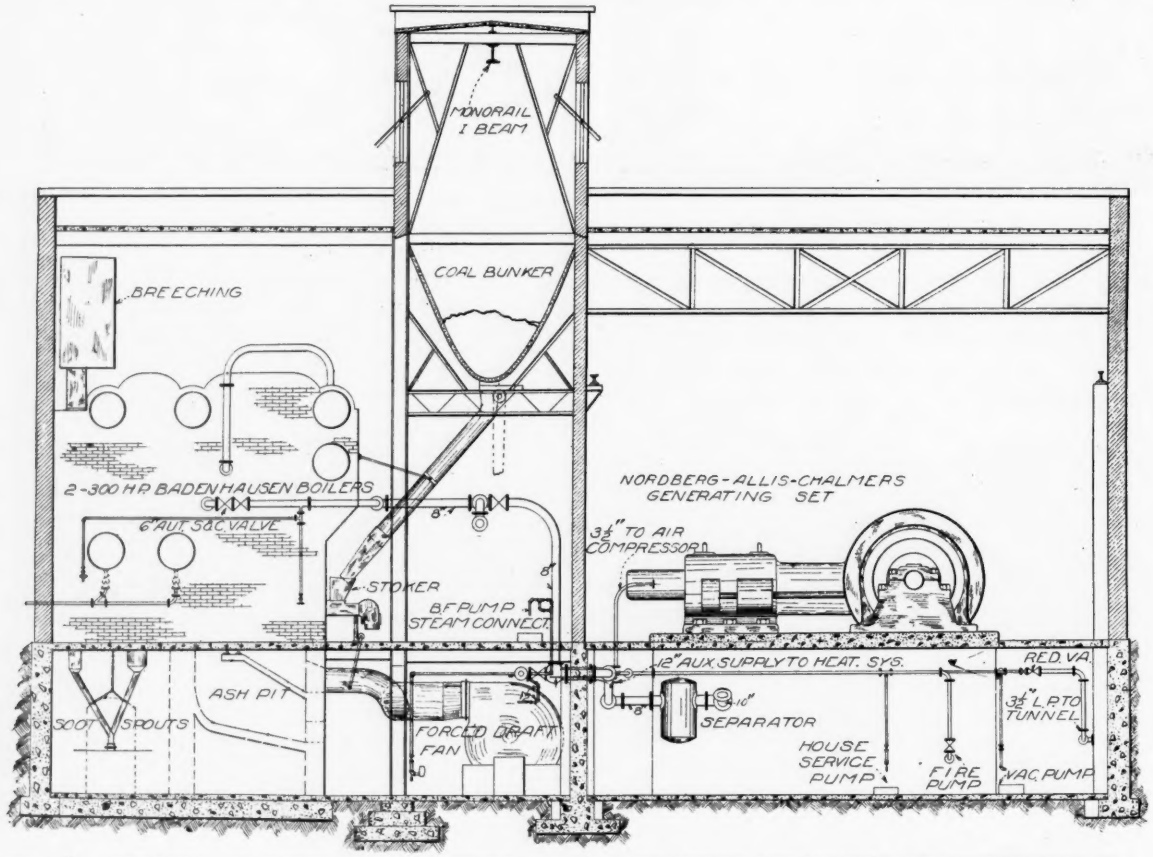


FIG. 6. ELEVATION OF POWER HOUSE SHOWING HIGH-PRESSURE PIPING AND LOCATION AND CONSTRUCTION OF COAL BUNKERS AND MONORAIL SYSTEM

Each boiler is equipped with Vulcan soot blowers and all of the soot removed from tube and shell surfaces is deposited in receiving chambers or hoppers, of which there are two for each unit, located at the rear of the setting. The bottom outlets of these hoppers are fitted to 6-in. down spouts which terminate in a common discharge of like size equipped with a gate valve and with outlet 3.5 ft. above the floor line to accommodate the passage of the cars into which the soot is discharged.

Water Supply

Ordinarily, water for all purposes is taken from an artesian well and by means of an air lift is delivered to a cylindrical concrete reservoir of 110,000 gal. capacity

located at a distance of approximately 104 ft. from the power house, which in turn is connected to this reservoir by two supply lines, one 4 in. and the other 12 in. diameter. The former is used exclusively for the boiler feed and general house supply and terminates in the basement of the engine room in a 4 by 2 by 4-in. reducing tee, the 4-in. outlet of which connects with the suction of the house service pump while the 2-in. outlet connects with a line of like size leading to the boiler room. Here the two lines are interconnected and valved to allow the feeding of the boilers to be accomplished by reciprocating pumps after the water has been passed through the softener and the heater, or direct by means of 1.5-in. Hayden and Derby Metropolitan Injectors, with which each boiler is equipped. When the injectors are used, the supply is taken through the 2-in. raw water line exclusively.

The softener installed is a Bartlett-Graver unit of 4000-gal. capacity and is connected to a 35,000-gal. per hour Hoppes heater through the medium of a 3-in. line which together with a 4-in. line from the heating returns tank terminates in a header carried above the shell of the heater, and connected thereto by two 3-in. bends.

Two boiler feed pumps, one a 7 by 4¾ by 8-in. Prescott and the other a 7 by 4½ by 8-in., Manistee Iron Works, are located directly below the heater and are fitted with Y-connected 4-in. suctions and 3-in. discharge valves in a manner such that either one may be operated alone or both simultaneously. A 3-in. feed header is carried along the boiler fronts and is connected to the boilers through individual 2-in. lines which are also tied in with the injectors by 1.5-in. branch leads equipped with the necessary control valves. Regulation of the feed is cared for by Copes regulators.

To meet any emergency which may at any time arise, other interconnections make it possible to supply the water softener, heater, boiler feed and house service lines by means of the fire pump, a 16 by 9 by 12-in., 750-gal. per minute Fairbanks-Morse Underwriters unit located in the basement of the engine room next to the house service pump. A 10 by 12-in. reducer connects the suction of this pump to the 12-in. line coming from the reservoir.

In the Engine Room

All machinery in and about the works, with the exception of a number of steam hammers, is operated by electric current. The equipment installed for supplying this service consists of a 28 by 32-in. single cylinder Nordberg poppet valve engine direct connected to a 500-kw. 250-v. Allis-Chalmers direct-current generator, and a 14 by 24-in. Allis-Chalmers Corliss engine driving a 415-amp., 220-v. electric unit of like make. Under present load conditions the former is capable of carrying the entire day load while nights and Sundays the Allis-Chalmers unit is depended upon to supply the necessary lighting current and exhaust steam for heating purposes.

Many of the shop tools and lifting devices are pneumatically operated and for the air supply of these and the air lift used in conjunction with the water system a Rand compressor having a capacity of 707 cu. ft. of free air per minute has been installed. This is a two-stage unit with steam cylinders having dimensions of 12 by 16 in. each and high and low-pressure air cylinders of 11 and 18 in. respectively.

Steam Piping

Steam, as stated above, is ordinarily generated at 150 lb. pressure, but before leaving the boiler is superheated 125 deg. F. Six-inch leads each carrying an automatic stop and check valve and an extra heavy gate valve deliver the steam to the boiler room header which, by means of an 8-in. line, connects with a main header of like size and a 6-in. auxiliary header. These have been placed below the boiler room and engine room floors and are so interconnected at various points as to insure a continuous supply of steam to any one or all of the engines or pumps even though it may become necessary to cut out any section or sections of either header for repairs or otherwise. Generally, however, the engines take steam from the 8-in. main header, the Nordberg engine through an 8-in. branch and the Allis-Chalmers unit through a 5-in. branch; both of these are equipped with the necessary separators and as in the case of the header are carried below the floor thus eliminating much overhead piping.

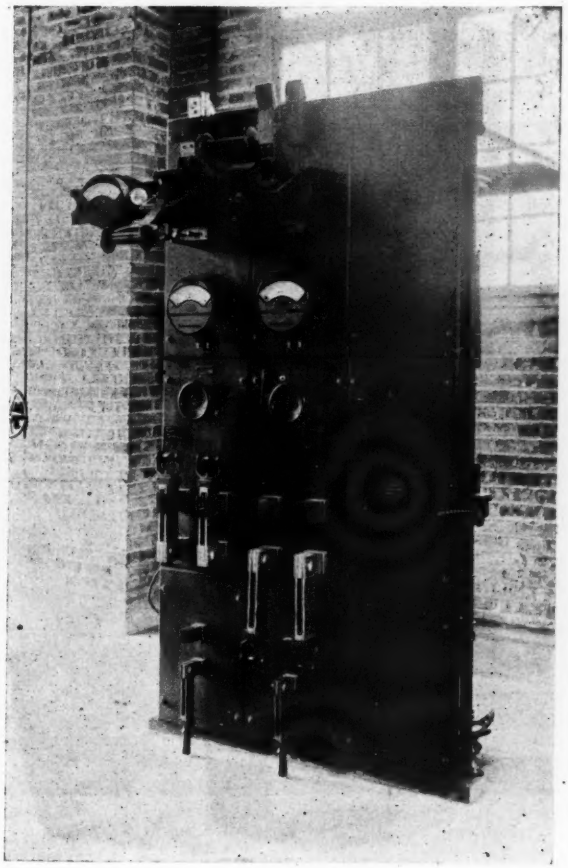


FIG. 7. GENERATOR CONTROL BOARD

Each fan engine receives its supply of steam through a 1.5-in. lead connected to the auxiliary header which also serves the various pump and forge shop hammer supply lines.

An independent 3.5-in. line serves the fire pump—while another line consisting of 4.5, 3 and 2.5-in. sections carried near the north wall of the engine room basement serves the air compressor, the house service pump, the vacuum pump and the branch leading to the hammers in the forge shop which in addition to a 2-in. shut-off valve is fitted with a 2 by 3.5-in. Mason reducing valve for reducing the line pressure to 100 lb.

All steam consuming units operate non-condensing. The exhaust from these is delivered to a 14-in. L-shaped main and is employed for the heating of the building, the boiler feed and the domestic water supply; any excess which may exist is discharged to the atmosphere through a 14-in. atmospheric line equipped with a Swartwout exhaust head.

The main section of the exhaust header with a length of 27 ft. 9 in. is located in the engine room basement and is carried parallel to the boiler room wall to a point within about 3 ft. of the south wall of the building, where it turns and is continued to the entrance of the tunnel

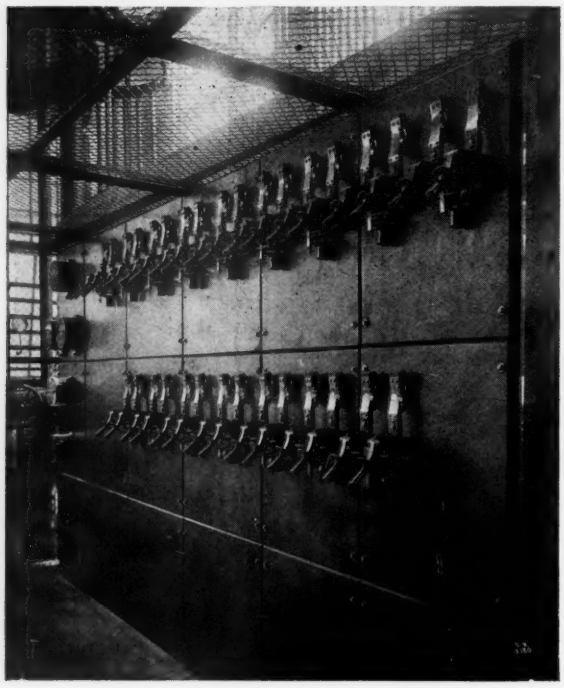


FIG. 8. DISTRIBUTION BOARD IN MACHINE SHOP

at the southwest corner of the basement. A second branch, that to the heater and atmospheric exhaust, leads into the boiler room where, by means of a riser carrying a 14 by 8 by 14-in. tee it connects with the heater and through the medium of a 14-in. back pressure valve and the necessary run of piping to the exhaust head on the roof.

A 100-gal. per hour heater supplied with raw water through a 1-in. line and with exhaust steam through a 1.5-in. line connecting with the exhaust from the fan engines and boiler feed pumps furnishes the necessary hot water for domestic purposes.

The heating system is of the vacuum type and consists of 30,000 sq. ft. of radiation distributed through the various buildings, and while ordinarily exhaust steam is employed this may be replaced or augmented by live steam reduced to the pressure usually carried on the system by means of a reducing valve provided for that purpose. Condensate is returned to the plant through a 5-in. line connecting with the suction of an 8 by 12 by 12-in. vacuum pump capable of handling 40,000 sq. ft. of radiation and located as shown in Fig. 5 in the basement of the engine room near the tunnel entrance. The discharge of this pump connects with a 4-in. line extending through the engine room basement and into that of the boiler room where it is carried upward to a 200-gal. storage tank placed directly above the feed water heater and to which through a 4-in. gravity line the condensate is conducted as required. A 2-in. overflow connecting with the city sewers cares for all excess water the heater may be called upon to take.

Steam, Water, Air and Electric Distribution Systems

As shown in Fig. 2, which illustrates the relative arrangement of the various buildings comprising the Pawling & Harnischfeger Works, the new power plant has been placed at some distance from the shop and offices and in order therefore to avoid carrying steam, air, water and electric lines leading to and from the power plant overhead, underground distribution was employed. To house this system a reinforced concrete tunnel was constructed. This, as may be seen by referring to Fig. 2, extends from the southwest corner of the power house basement to a point approximately 234 ft. west, where its direction changes following a course due south for a distance of 239 ft.

The weight of the tunnel is carried by a mat of reinforced concrete 8 in. thick and in order to furnish ample room not only for passage but also to make repairs and changes when such become necessary, the tunnel has been constructed with a width of 5 ft. and a height of 6 ft. Top and side walls are each 10 in. thick, and to insure stability and rigidity of the structure the latter are joined to the supporting mat by means of a dovetailed joint. The section of the tunnel shown in Fig. 2 will illustrate the form of construction employed.

Along one side of the tunnel and on standards placed 12 ft. apart are carried the various pipe lines, while to the opposite wall are attached the electric lines. Each of the standards consists of an upright member, a 6-ft. length of 2 by 2 by 3/16-in. angle iron and three horizontal pipe-carrying members, each a ¾-in. rod carrying a 1-in. pipe, thus providing a roller support. The uprights are secured in place by means of ½-in. pins embedded in the concrete and attached to adjustable lugs bolted to the angle irons and as a means of reinforcement and proper supporting power the ends of the 1-in. rods opposite the angle irons are likewise embedded in the concrete.

One of the most interesting features of this installation is the scheme employed in connection with the electric distribution system.

In central power or industrial installations in which the generating equipment is placed at about the approximate so-called center of gravity of the system, it appears desirable from standpoints of operation and economy to place the distribution control equipment as near the electric generators as possible and in charge of the station operators. Where, however, such conditions as exist at the Pawling & Harnischfeger Works are met, in which

the power plant is at some distance from the actual center of distribution and in which all of the electrical equipment outside of that used for the purpose of generation is under the care of a shop electrical maintenance organization, an arrangement differing somewhat from the ordinary may be employed to advantage. Engineers engaged on this job devoted considerable time and thought in the working out of a scheme to meet the conditions here existing and as a consequence the only electrical control equipment placed in the power house is that used in connection with the generating units. This consists as shown in Fig. 7 of a three-panel generator board carrying the necessary machine and equalizer switches, circuit breakers, field rheostats, ammeters and a swing bracket voltmeter with pilot lamps. Attached to the bus bars are heavy trunk cables carried by way of the engine room basement and the tunnel to the machine shop, where the panel distribution board, illustrated in Fig. 8, is installed.

The engineering work in connection with this project was done by Woodmansee & Davidson, Chicago, with A. D. Bullerjahn representing the Pawling & Harnischfeger interests; the plant is now in charge of Herman Bahr, chief engineer.

Evolution of Heat Insulation

MATERIALS TRIED, COMBINATIONS, TEST RESULTS AND PRESENT PRACTICE. BY AUSTEN BOLAM

LESS than half a century will cover the entire history of modern heat insulation practice—which period also coincides with the increase of working steam pressures from a 100-lb. maximum to 250 or 300 lb. as the usual daily load in many of our leading steam plants.

Prior to the advent of higher pressures, the need for better insulation was only dimly realized. Business was good, coal was cheap and economy had not come into fashion. It was the "constructive" period of American manufacturing. "Big business" had yet to be invented and the "efficiency expert" was unknown.

Pipe coverings there were, of course, but the very names of many of them are forgotten today. Weird combinations of "lath and plaster," wool of sheep and likewise of slag, straw and chaff, all had their day and their advocates.

Looking through back volumes of the A. S. M. E. Transactions, one comes across some interesting information on these early days. It was in 1883, for instance, that Professor J. M. Ordway of Boston announced the results of a series of tests, made on behalf of the Mutual Fire Assurance Companies of that city, who were, very properly, alarmed at the number of cases of "spontaneous" combustion, originating in the pipe and boiler coverings of that day.

We read a list of coverings in this report in the Transactions, Volume V. As an indication of the then state of the science of heat insulation, they are illuminating, if scarcely convincing. Here are a few of them:

Slag wool, wooden cage, burlap, cotton cloth: Asbestos fiber, asbestos paper, hair felt, repeated and covered with canvas: Asbestos paper, hair, cardboard: Air space, tin casing, hair felt, canvas: Clay, paper, hair felt, laths, plaster: Paper cylinder: Silicated rice chaff, cotton cover: Air space, straw board, hair felt: Fossil meal, plaster with hair: Air space, straw board, peat moss, cotton cloth: Air space, hair felt, laths, plaster: Slag wool, straw board: Rye straw rope, 4 plies cotton cloth: Silicated hardwood, charcoal, cotton cloth wrapping: Carbon, plaster of paris, flour and hair plaster: Asbestos paste, clay and flax, paper pulp, mortar: Air space, tin casing, asbestos paper, tin casing: Meal, clay and hair, meal, clay, sawdust, flax fiber: Ashes, plaster of paris, flour, hair: Clay, refuse of vegetable fibers.

Some of the conclusions are interesting. For instance, he finds "rice chaff, moistened with water-glass, much more efficient than straw rope." A little further on he strikes the keynote of all modern insulation practice, but so casually that we fear he did not really realize the value of his discovery when he says: "Fibrous or porous matter acts mainly by virtue of its *entrapped air.*"

Ease of application and removal also receive the professor's earnest consideration. Rice chaff and similar materials were applied by means of a wire gauze cage encircling the pipe, over which the outer covering of cotton cloth was "tightly basted and sewed." The gauze was then slipped out and used for a fresh section. "Straw rope is easily wound, but in time it becomes so brittle that it is worthless when unwound again." On the question of durability, straw is again under fire, while "coverings that contain flour or meal are likely to be gnawed by rats and mice."

We note also that the fibrous "air holding" coverings are again commended as the most efficient and the close-textured "plaster" coverings are the least.

During 1884 Professor Ordway continued his experiments. He eliminated many of the old fallacies and at the close of his report dimly indicates the verge of another great discovery, destined later to revolutionize the whole practice of heat insulation. Let us again quote him: "At first sight, it might seem as though *magnesia* is too costly to be taken into account, but . . . there is nothing but lack of demand to hinder a very economical production of magnesia alba, . . . the lightest and nicest of all incombustible non-conductors."

At this time magnesia, classed as a drug, was not yet manufactured on a commercial scale. The vast deposits of magnesian limestone in Pennsylvania and elsewhere had barely been tapped. Only in powder or paste form could it be applied to steam pipes, in which condition its virtues were only partially manifested.

About 1885, Hiram M. Hanmore, who was a practical pipe coverer, began to mix magnesia alba with the sawdust and other materials he was using, and he communicated his discovery to Dr. R. V. Mattison, who was a large manufacturer of the magnesia product. The worthy doctor was somewhat prepared for this information because he had been having troubles of his own, through the fact that the magnesia powder, settling on the steam pipes in his drying room had almost cut off their supply of heat, necessitating continuous brushing

off, to enable them to function. The doctor was not an engineer, but he was quick to grasp the value of Hanmore's "tip" and after many costly experiments the covering we know today as "85 per cent Magnesia" was born.

The name is perhaps unfortunate, but it has "stuck." As a matter of fact, it was first adopted simply to denote a certain percentage of combination between the magnesia and the binding material needed to make the magnesia into a homogenous mass, capable of being molded into blocks or sections and of being handled with impunity.

It is a long time before we find anything of further interest in the "Transactions," but in 1893 we find W. A. Pike, of Minneapolis, telling the A. S. M. E. how he carried steam some 4600 ft. in a cast-iron pipe protected by mineral wool in a square box or trough. Discussion of this paper brought out some valuable information as to the evil effects of excessive condensation with its accompanying "hammer," on both pipes and engines.

Evidently in the interval a great advance had been made in heat insulation. We hear no more about straw ropes or rice hulls, but at this same meeting W. A. Pearson tells of his experience with magnesia. He says in part: "We found that one layer of magnesia blocks 1⅜ in. thick, then one layer 1 in. thick on top of the first, one layer of ⅜ in. magnesia plaster next and two layers of canvas on the outside, made a perfect covering, as the thermometer showed that we held every unit of heat generated in the covering." It certainly should have done so.

Even prior to 1887 the United States Navy had been experimenting with various heat insulations, but in that year a committee composed of Chief Engineer John W. Moore, Assistant Engineer C. R. Saulsbury and Cadet Engineer B. C. Simpson definitely recommended the new 35 per cent magnesia covering for "purchase and use in the service." It has remained the standard covering of the Navy ever since.

Returning once again to our old friend, the "Transactions," we find in Volume XVI a very important contribution by George M. Brill, of Syracuse. We find also that an entirely new series of coverings have appeared on the market. "Hair felt" and "fossil meal" are still used; but in place of the others we find magnesia, "rock wool," mineral wool and others. That there had been a radical improvement in the manufacture of heat insulating materials is, however, shown by the fact that hair felt, well up in the Ordway tables, was placed by Brill at the foot of the list.

In 1898 Professor C. L. Norton was heard (Transactions A. S. M. E., Volume XIX). He condemns hair felt and all fibrous coverings in unmeasured terms, but he finds cork the most efficient of the insulations tested. While cork is undoubtedly an extremely efficient nonconductor, it is notable that since that day the rapid increase in pressures and steam temperatures has gradually eliminated all organic materials from the list of practical, high-pressure coverings. Cork, hair felt, etc., have, however, played a valuable part in the evolution of artificial freezing, for which their undoubted efficiency makes them particularly suitable.

Apart from cork, Professor Norton strongly favors magnesia, but pertinently calls attention to "the danger of cheap coverings, purporting to be magnesia, which do not contain the proper proportions of magnesia and the necessary asbestos fiber binder."

He also stated that in testing magnesia 6 yr. old, he found it identical with some bought in the open market at the time.

The tests of George H. Barrus (Transactions A. S. M. E., Volume XXIII) were somewhat inconclusive, as they were made to ascertain the condensation of "dead" steam in closed pipes. This type of test is fallacious since it bears little relation to the actual conditions obtaining on "live" steam lines. As a result, Mr. Barrus awarded the palm to a combination of hair felt and asbestos. He also found that the efficiency of the coverings was greater on large pipes than on small ones. This is easily explained under the described conditions, since the larger pipe, holding more heat, would naturally cool more slowly.

Nineteen hundred and two is notable as the year in which Henry M. Stott made his series of tests for what was then the largest power plant in the world, that of the Manhattan Railways Co. Mr. Stott was an eminent, practical engineer. He had unlimited resources at his command, but what makes his conclusions the most interesting is the fact that he was a *buyer* of insulation and as such was interested only in securing certain conditions which he laid down and which can scarcely be improved upon today. They were:

"Investment in covering.

"Cost of coal required to supply lost heat.

"Five per cent interest on capital invested in boilers and stokers, rendered idle through supplying lost heat.

"Guaranteed life of covering.

"Thickness of covering."

That Stott decided on 85 per cent magnesia coverings, and that these coverings are still in use in that plant, is of relatively less interest than the fact that for the first time a large user of power preferred to make his own tests. It seems almost a pity that his example has not been more largely followed.

Another long gap in the history of heat insulation follows, but meanwhile its use had been almost universally accepted. No longer did large steam users debate whether they should cover their pipes or not. Insulation had become an accepted principle of modern steam practice.

Consequently the lengthy experiments of Professor L. B. McMillan (published in the Transactions during 1915) do not have the same historical interest as the earlier ones, already quoted, since they are more or less confirmatory of current practice. They may almost be said to mark the close of the experimental stage. The apparatus involved is costly, while the actual results differ in no practical degree from those of Stott 13 yr. earlier.

Modern engineering is no longer carried on by "rule of thumb." Rising costs of coal have made strict economy imperative. Far more attention is paid today to what were in the days of our forefathers considered "minor" details, and the engineer who ignores the need for economy plus efficiency is daily finding it harder to get a job.

The only notable event of the past few years has been the formation of the Magnesia Association of America and the endowment by that body of an industrial fellowship for research purposes at the Mellon Institute of the University of Pittsburgh.

It is too early yet to prophesy as to the results of this research, but it is safe to infer that it will lead to an even better understanding of the great questions involved under this apparently simple but really complex subject of scientific heat insulation.

The drastic shortage of coal which will likely continue indefinitely has attracted much attention to the subject of fuel economy and particularly to the need of more and better insulation as a remedy for the shortage.

Saving Waste Heat from Gas and Oil Engines

WASTE HEAT AVAILABLE; METHODS OF UTILIZING GASES TO HEAT WATER IN RADIATORS, HEATERS AND BOILERS. BY CHARLES L. HUBBARD

MOST plants, where power is generated, require heat for warming the buildings during the winter, and often hot water is necessary throughout the year for either industrial or domestic purposes.

When steam power is used, it is a simple matter to utilize the heat contained in the exhaust for these purposes. With the increased use of gas and oil engines, there is an opportunity for the utilization of waste heat which has not yet been given the attention which it should have received. While the heat commonly lost in the jacket water and exhaust of a gas engine does not equal that contained in the exhaust from a steam engine of equal power, still it is an important item in these days of coal shortage, and should be utilized to the fullest extent.

A series of tests made some years ago at the University of Cincinnati upon a number of gas and oil engines of different sizes gave thermal efficiencies ranging from 21 to 27.1 per cent, or an average of approximately 25 per cent, showing that about 75 per cent of the heat supplied was lost in radiation, jacket water and exhaust. Modern engines of standard make claim somewhat higher efficiencies, ranging from 30 to 34 per cent.

In order to make any true comparison of the efficiencies of a steam or gas engine for any given case we must take into account the cost of the heat supplied to each engine, whether in the form of steam, oil, illuminating gas, or producer gas; the efficiency of the engine; and the proportion of waste heat which may be utilized throughout the year. Other items to be considered, which are outside the scope of the present article, are cost and maintenance of equipment, interest and depreciation, labor, etc.

While fuel costs must be estimated in each particular case according to location and time, it may be of interest to give figures relating to the fuel cost of two medium size pumping plants of practically the same capacity, one operated by means of a producer plant with gas engines and the other by steam. Reducing results to a common basis, the fuel cost for an average of 4 yr. was in the ratio of 1 to 1.63 in favor of the gas outfit. When the total expense was taken into account, including fixed and operating charges, the ratio for the same period was 1 to 1.43 in favor of the gas-operated plant. In making this comparison, it should be stated that the load factor was somewhat less for the steam plant, which would reduce the ratio a small amount when placed upon exactly the same basis.

While these tests were made when prices for both fuel and equipment were much less than at present, the proportion would probably hold much the same. Experience has shown that a large proportion of the heat contained in the fuel supplied a gas or oil engine may be recovered from the jacket water and exhaust by means of suitable equipment.

The point which it is desired to bring out by the comparison thus made is the importance of saving the waste heat from an internal combustion engine.

Engineers and plant owners have come to realize the value of the exhaust from a steam engine, but the relative value of the waste heat from a gas or oil engine does not seem yet to be fully appreciated. Although there are occasional installations for this purpose, they are, as yet, exceptions rather than the rule.

Let us assume that in case of a certain steam engine the fuel cost of the steam for a given amount of power is \$1.63; also that the efficiency is 8.6 per cent, and of the remaining heat (91.4 per cent), 88 per cent, or $0.914 \times 0.88 = 0.8$, or 80 per cent of that supplied the engine may be utilized for heating purposes. The value of this, for the unit of power assumed, will evidently

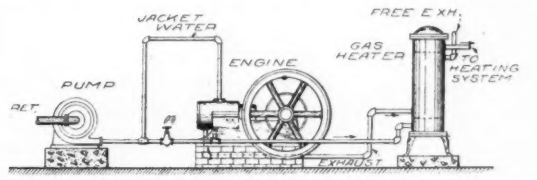


FIG. 1. ARRANGEMENT FOR HOT WATER HEATING WITH WASTE HEAT FROM GAS OR OIL ENGINE

be $1.63 \times 0.8 = \$1.30$, leaving the net fuel cost for power, $1.63 - 1.30 = \$0.33$.

The fuel cost for gas to generate the same unit of power, on a basis of 1 to 1.63, as previously given, will be \$1.00. If, now, we realize an efficiency of 25 per cent with a gas engine, and assume that 80 per cent of the remaining or waste heat is utilized, then the actual or net cost per unit of power will be reduced to $1.00 - (0.75 \times 0.8) = \$0.40$. If jacket water were purchased at city rates, the net cost of power would be still less, because this item would be eliminated if the same water were used over and over again in a heating system.

With no attempt to utilize waste heat in either case, the fuel cost per unit of power would stand at \$1.63 for steam and \$1.00 for gas. A modern steam plant would make every effort to reduce this by utilizing the exhaust, and might bring the cost down to 33 c. under the most favorable conditions. Ordinarily, no attempt would be made to utilize the waste heat from the gas engine and the cost per unit of power would still stand at \$1.00, as against \$0.33 for steam.

By utilizing the waste heat in this case, the same as for steam, the power cost might be brought down to $0.38 or $0.40 per unit, which is approximately that of steam, which goes to show that it is almost as important to utilize the waste heat from an oil or gas engine as the exhaust from a steam engine. To be sure, exhaust steam is in a form to be easily transmitted wherever needed, while the heat from a gas engine must first be transferred to some other medium as air, water or steam.

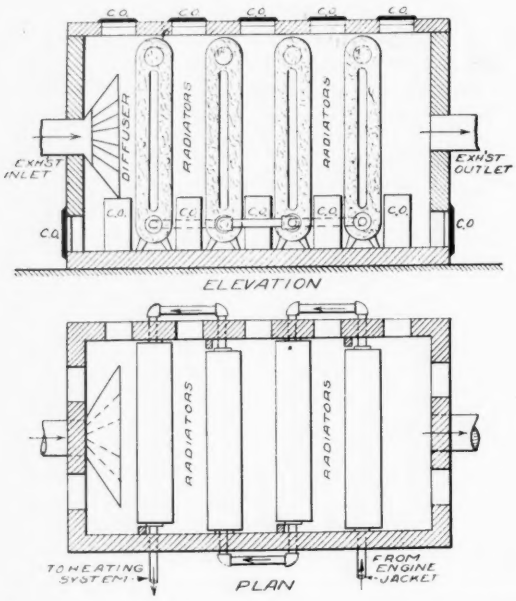


FIG. 2. EXHAUST GAS ECONOMIZER MADE UP OF CAST-IRON RADIATORS

The figures used in these comparisons are only approximate, but serve to show general relations.

Methods of Utilizing Waste Heat from Gas and Oil Engines

There are different methods of utilizing the waste heat from gas and oil engines, and a choice will necessarily depend upon local conditions. A general rule to be followed in any case, whether for a gas or steam engine, is to employ the exhaust in such a way as to utilize the largest amount when the whole year is taken into account.

If a certain amount of hot water is continuously required throughout the year, for industrial or other purposes, then it would be best to use the waste heat for this rather than for warming the building or a portion of it for only part of the year. If only part of the exhaust could be utilized in this way, it might be best to use as much as possible for water heating and turn the surplus into the general heating system for warming the buildings during the winter.

Conditions might be such that while gas engines were used for power purposes a considerable amount of steam might be required throughout the year in manufacturing processes where the condensation was not returned to the boilers. In cases of this kind, the waste heat from the engine might be employed for heating the feed water, or, if the condensation was returned to the boiler and so used over and over again, the waste heat might be used directly for generating low-pressure steam for supplementing that furnished by the boiler, or for superseding it entirely if the amount required was within the capacity of the engine exhaust (including jacket water).

A study of a number of tests made under normal working conditions shows that from 3600 to 4000 B.t.u. per hp. per hr. may be utilized from the waste heat of a combustion engine when working at full load. As the load decreases, the efficiency of the engine falls off and the proportion of waste heat is greater, so that for one-quarter load the available heat which may be utilized in this way will be increased from 50 to 75 per cent. The above results are obtained by utilizing the heat contained both in the jacket water and exhaust gases. The equipment required will depend upon the use made of the heat.

For heating the building with hot water under forced circulation, the arrangement shown in diagram in Fig. 1 may be made use of. In this case, the return water from the heating system is first forced through the jacket of the engine, or such portion of it as will pass through the openings under the normal pressure commonly used with forced hot-water heating. In the arrangement shown, the engine jacket is placed on a bypass and the valve, "A," in the main line throttled down until the pressure head reaches the allowable maximum. For the most efficient results, it is desirable that the water pass through the jackets at a velocity from 5 to 10 times that ordinarily employed. The idea of this is to remove any bubbles which may adhere, even temporarily, to the walls of the jacket and which, if allowed to remain, reduce the flow of heat from metal to water. After leaving the jacket, the water passes through a gas heater or economizer where it is exposed to the exhaust gases which have a temperature commonly ranging from 500 to 900 deg. The requisites for a high efficiency in the economizer are high velocity of

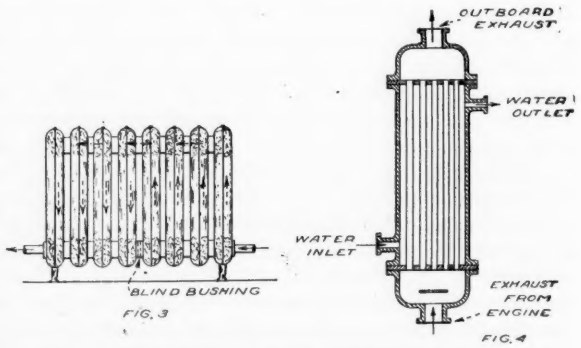


FIG. 3. LOCATION OF BLIND BUSHING IN RADIATOR
FIG. 4. CLOSED FEED-WATER HEATER USED AS EXHAUST GAS ECONOMIZER

both gases and water, with the currents flowing in opposite directions. For ordinary conditions, with the jacket and economizer in series, from 2.5 to 3 sq. ft. of heating surface per engine horsepower should be provided in the economizer. When the jacket and economizer are in parallel, that is, each receiving water from the heating system at the same temperature, 2.2 sq. ft. of surface

will be ample, as the water entering the economizer is at a somewhat lower temperature than with the series arrangement.

Experience has shown that wrought-iron tubes are not, in general, satisfactory in the construction of an exhaust gas heater or economizer, owing to their rapid deterioration under the conditions of actual service. Cast iron seems to be necessary for durability, and in making up a heater of this kind provision should be made for easy access for cleaning, as the heating surfaces become fouled and their efficiency correspondingly reduced. In the arrangement shown in Fig. 2, the economizer is made up of direct hot-water radiators of the sectional type, with a blind bushing in the lower header to produce a flow of water through them, as indicated in Fig. 3. These radiators are enclosed in a brick housing, each alternate radiator being offset or staggered in order to break up the gas currents and so secure a better distribution of heat. The water is forced through the radiators in series in the case of small and medium size heaters. In larger ones, where a greater area is required for the passage of the water, two or more may be connected in parallel, and these groups in series. A baffle should be placed in front of the exhaust inlet to spread the gases and prevent them from impinging directly upon the first radiator.

Cleaning is provided for by removable sections in the top of the housing, through which a brush may be used, and side doors between the radiators for removing the soot or other accumulations. All wrought iron pipe connections which are necessarily inside the housing should be protected from the direct action of the gases.

Indirect radiators would serve the purpose equally well provided the outer surfaces were smooth and all parts equally accessible for cleaning. It is evident, however, that pin radiation would not be adapted to this use, because of the opportunity for soot to collect around the projecting pins and the difficulty of cleaning between the sections.

Heaters of the type shown in Fig. 2 are for units of the larger size. For smaller plants a very compact and efficient arrangement is shown in Fig. 4 in which a feed water heater is substituted for the radiator and brick chamber arrangement previously described. A heater of this type with brass or copper tubes and cast-iron shell, so constructed as to avoid the use of packing which might be injured by the hot gases, would be durable and very efficient.

In this case, a tube surface of 2.2 to 2.5 per horsepower should prove sufficient. The objection to this arrangement is the difficulty of cleaning the tubes, but this may be gotten around quite satisfactorily by passing the water through the shell and the hot gases through the tubes, in which case the top of the heater may be removed and the tubes cleaned with a flue brush.

Hot Air Heating

A typical arrangement for hot-blast heating is shown in Fig. 5. This is especially adapted to the heating of shops where the entire building is made up of a single room.

The heater, in this case, is a combination affair, part of the surface being heated by the jacket water and part by the exhaust gases. The exhaust surface is made up of vertical cast-iron pipes made with square flanges at the ends, which form the top and bottom of the gas chamber when in place. The spaces between the square pipe ends are filled with an asbestos sheet packing and drawn up in both directions by means of tie rods.

The heating coil containing the jacket water is so made up that the pipes run inside the cast-iron flues, as shown in the drawing. The jacket water is circulated by means of a small pump and flows through the coil as indicated. The exhaust gases pass among the vertical flues, which are enclosed in a brick chamber. A diaphragm at the center, carried nearly to the top, is provided for distributing them over the entire heating surface. The cold air supply enters beneath the heater at the exhaust and passes upward through one-half of the vertical flues and downward through the other half and thence to the fan, as indicated by the arrows. With this arrangement, the air is exposed both to the hot

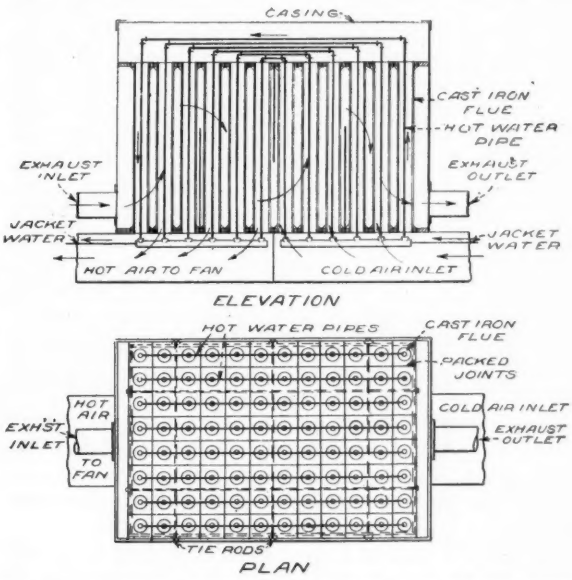


FIG. 5. COMBINED HEATER FOR USE IN CONNECTION WITH HOT BLAST HEATING

flues and the hot-water coil in its passage through the heater.

In making up this type of heater, 4-in. cast-iron pipe may be used for the flues and 1-in. wrought-iron for the inside hot-water pipes passing through them. Approximately 2.8 sq. ft. of heating surface in the outer tubes or flues should be allowed per engine horsepower.

Arrangements of this general type have been used with good satisfaction and the cost of installation has been but little more than for a system of direct steam radiation, using the exhaust from a steam engine.

Generation of Steam

In certain cases, it is desirable to utilize the waste heat from gas engines for the generation of low-pressure steam, either for industrial purposes or for supplementing a steam heating system already installed. This calls for a gas boiler in place of the economizer already described for use in connection with hot water heating. In this case, the steam system may be made separate from the engine jacket by using the

arrangement shown in Fig. 6, which consists of an ordinary feed-water heater, through which the jacket water is circulated in place of exhaust steam; and a gas boiler supplied with the hot gases from the engine, in place of a fire upon its own grate. The feed-water heater should be of a size capable of extracting at least 1600 B.t.u. per horsepower of engine per hour, and the gas boiler at least 2000 B.t.u. per hour in addition to this, and it would be well to increase these capacities 25 per cent as a factor of safety. Here, as previously stated for series work, the boiler should contain from 2.5 to 3 sq. ft. of heating surface per engine horsepower. The type of boiler will depend somewhat upon local conditions, but for low pressures of 10 to 15 lb., a good form of cast-iron heating boiler should prove satisfactory, the exhaust gases being discharged into the fire box and passing upward through the flues and outboard by way of the smoke pipe opening.

A method suggested for breaking up the pulsations of the engine, and producing a uniform flow of the hot gases through the passages of the boiler, is to cover the grates with a thin layer of coarsely broken fire brick and connect the exhaust below them. In this way, the ash pit acts as a muffler or equalizing chamber, while the fire brick serve to break up the irregular flow of the gases without adding materially to the resistance, thus

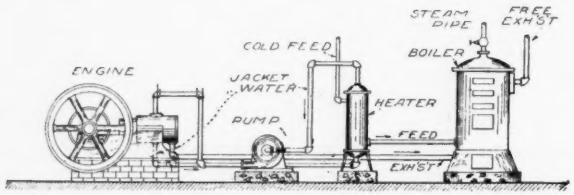


FIG. 6. ARRANGEMENT FOR GENERATING STEAM WITH WASTE HEAT FROM GAS ENGINES

approximating the conditions of a boiler under ordinary use.

While the various arrangements described have been tried out in actual practice in each case, they are presented chiefly as a basis for further development under the special conditions which may occur at different plants.

WATER HEATING FOR INDUSTRIAL PURPOSES

WHILE THIS is practically the same as for the warming of buildings by forced hot water circulation it may be well to note briefly certain requirements found in this particular class of work.

When the demand for water is approximately at the temperature of the discharge from the jacket, under normal conditions (120 to 150 deg.), the jacket water may be used directly as it leaves the engine and the exhaust may be employed to heat cold water to this temperature; that is, the two sources of heat are operated in parallel or independently, as may be most convenient. If a higher temperature is required, the jacket water should be passed in series through the exhaust heater.

By a proper arrangement of equipment any combination may be obtained without in any way affecting the efficiency of the engine and at the same time eliminating the nuisance of a smoky exhaust.

War-Time Conditions

BY GOVERNOR GARDINER OF MISSOURI

THE chief aim of a belligerent nation is to assemble and make effective in the shortest time possible an amount of physical force requisite to prosecute the war to a successful termination; for the more vigorously a war is pursued the better it is for all engaged therein. As to those movements and measures relating to the prosecution of war, time is of supreme importance. The fate of a nation may hang upon an interval of an hour, a day, or a week.

These facts should be borne constantly in mind by the people of the United States when they undertake to form or essay to express an opinion as to the propriety of any order made by their President or those acting under him.

In order to win the war with the minimum amount of friction, the people must adjust their mental processes to the extraordinary conditions that exist. In passing judgment upon a policy, they must not attempt to apply the tests appropriate in times of peace. Men must not be moved to captious criticism because of personal inconveniences which they would under no circumstances be called upon to endure in times of peace. They must have always in mind the thought that the ultimate object of this war is a lasting peace; that the hardships must be endured in order that they may at the very earliest possible moment resume their normal manner of living, and enjoy again the privileges and blessings of a free government, at peace with all the world.

We must steel ourselves to endure without grumbling the hardships entailed by this war. We must possess our souls with infinite patience, and not indulge in captious criticism. In forming or expressing an opinion relative to the manner in which the affairs of the nation are being conducted, we should resolve every doubt in favor of our government, and should not be influenced by personal or partisan ends.

The people throughout this section of America are "keeping the home fires burning." There is no difference of sentiment among them. They are determined to remain a unity in sentiment and in spirit. What they fear most of all is that selfish and designing interests may succeed in tearing down the efficient action of our industries.

A RECENT RULING of the War Trade Board, limiting the importation of rubber in order to conserve ship tonnage, will be of direct interest to power plant engineers, as it is likely to have a considerable effect on the supply, and possibly on the prices, of packings in which rubber is a constituent. The board, at its meeting on May 7, instructed the Bureau of Imports to limit the licensing for importation of crude rubber to a total of 25,000 tons from May 6 to and including July 31, the restriction to go into effect immediately. All requirements of the United States and allied governments for war purposes will be met in full, and the remainder of the 25,000 tons will be allotted to manufacturers of rubber products on the basis of their consumption during the year 1917. There is no indication as to what restrictions will be placed upon the importation of rubber after July 31.

COULD THIS WAR HAVE BEEN BLOCKED? WHAT WILL END IT? BY HERBERT S. HOUSTON, MEMBER OF THE CHAMBER OF COMMERCE OF THE U. S. A. ON ECONOMIC RESULTS OF THE WAR.*

THE AUTHOR AND HIS WORK

The two greatest questions looming before every man in America today are, first, the winning of this war, and second, the blocking of future wars. The two things are closely related. This war must be won before a feasible plan can be developed for stopping other wars.

A strong committee of The Associated Business Papers, Inc., had been carefully thinking of these important questions, and had reached the conclusion that economic pressure in the modern world must be the great force for the maintenance of peace. Just as this decision was made, Jesse H. Neal, secretary of the Associated Business Papers, Inc., learned that an important book was soon to come from the press on this very subject. It was written by Herbert S. Houston, one of the publishers of the World's Work and a member of the Committee of the Chamber of Commerce of the United States on the Economic Results of the War. Mr. Neal got in touch with Mr. Houston and secured galley proof of the book, which was eagerly read by the committee of the Business Press. There was complete and hearty agreement on the point that this book explained and interpreted, with singular clearness and force, the ideas of the committee, and the suggestion was made to Mr. Houston that his book should appear as a serial in the leading business papers. He immediately said he would be glad to have it used in that way, for he believed that the greatest thing before the world was the safeguarding of civilization against war, after this war has been won.

So Power Plant Engineering has pleasure in presenting these articles, "Blocking New Wars," from the book that has just come from the press. Mr. Houston, the author, has been a leading advocate of economic pressure as a sanction to put behind world courts.

He is vice-president of the publishing house of Doubleday, Page and Co., of which Walter H. Page, the American Ambassador to England, is a member. Mr. Houston has been president of the Associated Advertising Clubs of the World and has spoken before chambers of commerce throughout the country on business and economic topics. He has been, with ex-President Taft, on the Executive Committee of the League to Enforce Peace since it was formed, and at a war meeting in Providence, R. I., on May 2, at which Mr. Houston spoke, with Sir George Adams Smith of Scotland, he strongly advocated the immediate organization of a League of Nations, holding that this would be a war measure, as well as a peace measure.

VISCOUNT GREY of Falloden, while still Secretary of State for Foreign Affairs of Great Britain, expressed the opinion to an American diplomat that the great war might have been avoided if there had been in existence, during the fateful summer of 1914, the proposed League of Nations. Such an opinion from so responsible a statesman is certainly a challenge to a world at war. Not so much a challenge as to what might have been, for the angry waters of the past have rushed over the dam, but a challenge, certainly, to the future. For if the greatest war in history could have been avoided, then there is ground for hope that all wars can be avoided, or, at least, that the danger of their recurrence can be greatly lessened. So the opinion of Viscount Grey, particularly in relation to the probable world organization that will follow peace, is deserving of most serious examination.

If such a world organization as the widely discussed League of Nations had been in effective existence in 1914, on the basis of the American Proposals, what would have been its procedure when Austria refused to arbitrate its differences with Serbia? To begin with, the other nations in the League would have instantly joined in applying economical pressure to Austria. This would have taken the form of a complete trade embargo. Manifestly the more complete the embargo the more quickly it would have been effective. In that respect it is like the blockade. But if the League of Nations had been organized and its International Court established, it would have had both the authority and the machinery to make the trade embargo complete. The nations in the League would, of course have had the diplomatic representatives in Vienna. They would have notified the Austrian Government that the League had declared an embargo against Austria; that the embargo would continue in force until Austria took her case against Serbia to the International Court in accordance with her pledge to the League; that, furthermore, if Austria continued her recalcitrancy and persisted in her preparation to take her case to war for decision rather than to court, she would find their combined military and naval power on the battle line by Serbia's side.

The economic pressure against Austria would probably have proved too strong to be resisted. In 1912 the total export and import trade of the dual empire amounted to $177,000,000. Against this an embargo would have been raised by the nations of the League. And in connection with checking and, to a great degree, stopping this vast volume of trade, other repressive actions would have been taken against Austria-Hungary. Communication with the outside world would have been interdicted. This would have affected immediately the mails, the telegraph and cable lines, the telephone and wireless communications. Trains would have been stopped at the Austrian border. Foreign exchange would have been suspended, along with foreign trade. And Austria-Hungary would have stood in the eyes of the world a self-confessed, international outlaw, a country with which other countries would refuse to have commercial intercourse, or any communication or any relations whatsoever.

This would have been the pressure from without and it would have been accompanied, beyond question, by strong pressure from within. For it is impossible to suppose that many people in Austria would not have been exerting a powerful public opinion, meantime, against their government. Leaders in every section of Austrian life and society—in business, in finance, in the

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press, in the church, in the government itself—would have known the cause of all these drastic measures aimed at their country, and many of them would have stirred the people to demand that it be removed. When it was seen that the cause was Austria's refusal to keep her pledge, made with other nations, to take an international dispute to the International Court, an act of sheer outlawry, it is impossible to believe that Berchtold and his ministers could have ridden the storm of protest that would have arisen. And especially would this appear to be the inevitable reaction of the Austrian people, because their protest against their government's stand before the world in the indefensible position of an outlaw, would be given insistent force by their own uncalled-for suffering from the penalty of that outlawry. Even as they protested they would be suffering from the economic pressure of the world visited upon them because their government had refused to keep its word. And behind the economic pressure they would have seen clearly the combined military and naval power of the League of Nations as an oncoming vengeance against outlawry, ready to be used, if the economic pressure failed, to compel Austria to obey the law and take her case against Serbia to court.

The conclusion is unescapable that pressure from within would have been exerted and that it might have proved to be as powerful as the pressure from without. Between the two millstones, it is reasonable to believe, Austria might have had ground into her consciousness the truth that "righteousness exalteth a nation" and that a pledge when made must be kept.

The flaw in the armour of this hypothetical case is doubtless the war policy of Germany. At least the nations of the Entente Allies will be slow to believe that anything short of war could have stopped the war spirit of the militaristic party in Berlin, when "der Tag," for which preparation had been made for 40 years, at last dawned. But the League of Nations strong enough to coerce Austria, through either economic or military power, which Viscount Grey manifestly had in mind, would have included Germany; and it is such a league, with Germany included, that has been assumed in the illustration presented. As to the violence of this assumption for the Germany of 1914 there would be wide divergence of view. But for Germany in January, 1918, her Imperial Chancellor, Von Hertling, has stated officially that "the Imperial Government is gladly ready, when all other pending questions have been settled, to begin the examination of the basis of such a bond of nations." And the "basis" has been indicated clearly by President Wilson—"We fight for things we have always carried nearest to our hearts, for the right of those who submit to authority to have a voice in their own government, for the rights and liberties of small nations, for a universal dominion of right by such concert of free peoples as shall bring peace and safety to all nations and make the world itself free."

What Will End This World War?

But the great war came, as all the world knows. Economic pressure has been a vital factor in it from the beginning and it may prove to be the decisive one. Nation after nation has joined the fighting lines until the spring of 1918 finds 23 of them engaged. In the fullest sense it has been an international war. It was caused by the defiance of public law by Germany. That was and is the supreme issue. There were, to be sure, many auxiliary causes, but the overshadowing cause was the assertion by an autocratic power that it could employ military force to destroy the law of nations. When the Imperial Chancellor of Germany made that assertion in support of the actual invasion of neutral Belgium, the challenge was made that the democratic nations had to meet, if they were to continue democratic.

While it is true that the United States did not join in resisting this first challenge, although a great part of its citizenship believed it was the duty of the government to do so, the second challenge, declaring Germany's lawless purpose to defy the public law of the seas by the submarine, was resisted. So this country is in the war with the Allies, in support of the democratic principle that autocratic military power cannot defy international law. It is this issue that makes the war one between autocracy and democracy. And the war must be won, in the much-quoted because defining phrase of President Wilson, to "make the world safe for democracy."

From the beginning of the war, economic pressure has been a potent force and has been used in many ways, both new and old. Every nation engaged found it essential to place its whole industrial organization on a war footing. This has gone forward, in a quick progression, through industries to individuals. While Germany was able to effect a highly controlled organization, through autocratic power, more quickly than her enemies, they have all steadily developed and mobilized their resources for war purposes.

So as the war has gone on it has been manifest that economic power, as a war measure, was being engaged as completely as military power. And the end will come, so many observers believe, through the effective use of superior economic force, victory resting with the nations that possess that superiority. Of course the Allies are fully aware that they possess that superiority and they are determined that it shall be so used that they shall be the victors.

The sea power of Great Britain has been the dominating agency in enforcing economic pressure, through its use in intercepting Germany's imports and exports. In order to make this power as effective as possible the American doctrine of continuous voyage, developed in the prize courts of the United States during the Civil War, was adopted by both England and France. By this doctrine, if the ultimate destination of a cargo was proved to be an enemy port, that fact established its enemy character and made it liable to seizure. Proof had to be established in prize courts under the rules of international law. But swiftly the ocean-borne commerce of Germany was reduced and practically destroyed. The resulting pressure upon Germany and Austria has been widespread and most severe. This has been shown in innumerable ways, such as the rationing of the civil population, the hunger strikes, the reports in the German and Austrian papers, as well as through reports from contiguous neutral countries. While the actual figures of loss in both the export and import trade, are not available, they unquestionably represent a total so staggering that their effect can be considered one of

the most disastrous blows dealt the Central Powers during the war.

In addition to the blockade work of the English Navy, the whole economic power of the British Empire was invoked in January, 1916. Every self-governing dominion, every colony, every part of the Empire responded by boycotting German trade. The result was an embargo at the source, the form in which economic pressure can be made most drastic. Trade black lists were issued, restrictions were placed on the shipment of raw materials, coal ports were closed to ships that carried pro-German cargoes and presently a world-wide boycott was in force against Germany and her Allies that will continue with constantly increasing pressure until the war ends. In this tightening ring of commerce every nation of the Entente Allies has a part. The United States, in particular, used the economic weapon before it was able to use any military weapon and throughout the war its vast commercial power will be employed. This power has been mobilized in many ways. The Government in the spring of 1918 took entire control of foreign exchange; before that it had established a license system for export trade, and adopted a Trading with the Enemy Act of the most comprehensive and drastic character. All of these measures—and they have been adopted in some form by France and our other Allies—have combined in creating a financial and economic offensive agianst Germany that is likely to prove as powerful in ending the war as the military offensive.

But Germany has not been alone in the war in feeling the force of economic pressure. England and France have felt it, especially through the destruction of merchant ships by the submarine. This has limited the import of foods by both countries and made necessary carefully devised control of the food supply and regulation of its consumption. And economic pressure has been felt in America through the necessity laid on this country of saving enough from the stock of grain and meat and fats to supply the deficiencies among our Allies. For a number of months 84 Dutch ships were held in the harbor of New York, many of them loaded with supplies, because it was feared that a considerable part of their cargoes would ultimately find their way to Germany and because, moreover, these cargoes were sorely needed in England and France and Italy. Finally, in January, 1918, these ships were allowed to sail under guaranty that all the supplies they bore would go only to neutrals or to the Allies and that the ships would be returned to this country for use in our own carrying trade.

Within a few months after our entry into the war, a Food Administration was established under the direction of Herbert Hoover, and it has carried out the most comprehensive plans both for conserving and using the food supply and for increasing it. Similar plans have been followed by Dr. Harry A. Garfield, the Fuel Administrator. And the most drastic one, forbidding the use of coal in industry, with a few designated exceptions, for five consecutive days, beginning Jan. 18, 1918, and for nine Mondays, beginning Jan. 21, came as such a sudden shock that the whole country was fairly dazed. But the order was obeyed until it was rescinded after the third coalless Monday, and the coal situation definitely improved. And it can be frankly stated that the food and fuel orders brought the war more closely to America than anything else had done. On a wheatless or meatless day, especially if it were a coalless one, the news of fighting in France was borne home in a closer, sharper way than ever before. It was economic pressure of a very real sort and in a country that had always believed its resources were exhaustless.

As the war has gone on it has seemed probable that its end would come with the complete economic collapse of one or the other group of belligerents. It is largely a struggle for subsistence, both for armies and navies and for the belligerents back of them. The heavy gun is no more important, in forcing a decision, than the big cargo ship. Or to state it differently and more accurately, when the ships can supply the necessary men and munitions the guns will be able to force a decision and end the war.

Germany's drive for a separate peace with Russia was made both as a military and as an economic measure. After the treaty with Ukraine it was believed that food supplies would be forthcoming that would greatly relieve the situation with the Central Powers. To what degree this will be true, in view of the demoralized situation throughout Russia, is not clear; but, as far as it is true, it will prove to be an economic factor of definite consequence.

It is plain that this economic pressure, applied by all of the belligerents, has been a war measure, just as definitely as the fighting by armies and navies. And its operation in working to end so great a war illustrates the effects it would produce when used as a preliminary measure, by a league of nations against a single nation, to prevent war.

MAXIMUM PRICES at which coke may be sold at various ovens are announced in an additional regulation just issued by United States Fuel Administrator Garfield. The regulation makes the following prices:

For coke made at Coalmont, Tenn.—$7.25 for blast furnace coke and $8.25 for 72-hr. special or selected foundry coke.

For that made from coal from the Pratt seam in Alabama—$8 for blast furnace coke and $8.75 for 72-hr. selected foundry coke.

For coke made in Marion and Harrison Counties, W. Va.—$6.25 for blast furnace and $7.25 for 72-hr. selected foundry coke.

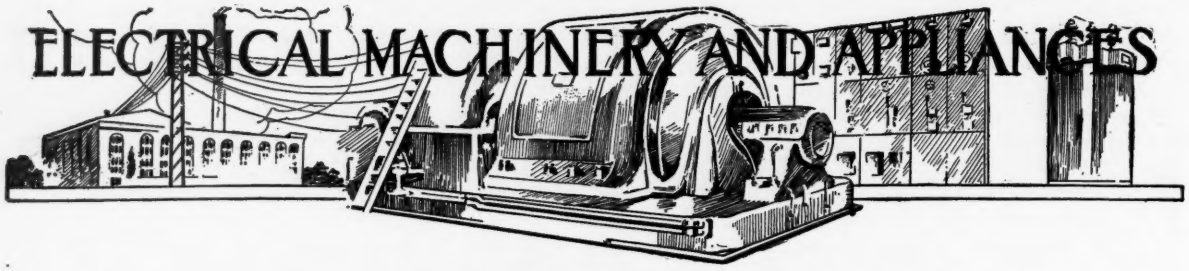
For coke made in Barbour and Randolph Counties, W. Va.—$6.75 for blast furnace and $7.75 for 72-hr. selected foundry.

For coke made in the State of New Mexico—$8.50 for furnace and smelting coke and $9.50 for 72-hr. selected foundry.

The prices were effective at 7 a.m. April 26.

PRODUCTION of bituminous coal is reported by the U. S. Geological Survey for the first 3 mo. of 1918 to be about half of 1 per cent more than for the same period of 1917, but less than for 1916. This was due to severe weather in January, as February production for 1918 was better than February, 1917, and only slightly less than 1916, while March, 1918, showed a gain over the same month for both 1916 and 1917.

ELECTRICAL MACHINERY AND APPLIANCES



Electric Storage Batteries---I

THEIR CONSTRUCTION, THEORY OF OPERATION, CARE, INSTALLATION AND APPLICATION

AN ELECTRIC BATTERY is a device for the direct transformation of chemical energy into electrical energy and when the re-actions which occur are reversible to a high degree by the passage of an electric current from some outside source, through the elements, the term storage battery is generally employed. Frequently these batteries are referred to as electric accumulators.

Primarily and from an electro-chemical standpoint, all storage batteries are either of the acid or the alkaline type, the former represented most prominently in commercial practice by the lead-sulphuric acid battery and the latter by the Edison nickel-iron-potash battery.

As in the voltaic or primary battery, each storage battery cell consists essentially of two sets of electrodes immersed in an electrolyte which, in the case of the lead-sulphuric acid type, consists of dilute sulphuric acid; and, although the mechanical construction of the electrodes in the various types of commercial batteries differs considerably, the underlying principle is the same in all. The bodies of the electrodes are of lead, and while primarily employed to carry the active material placed upon them they also conduct the electric current to and from this active material which in reality constitutes the actual electrodes. That used on the negative plate is finely divided or spongy metallic lead and that on the positive plate, peroxide of lead.

As the battery discharges the lead oxide of the positive plate and the metallic lead of the negative plate unite with the sulphuric acid and form lead sulphate and water; but as the entire process is reversible, the passage of an electric current from an outside source through the cell will cause a dissociation of the lead sulphate and the water, resulting in the formation of sulphuric acid and the deposit of metallic lead and lead oxide on each of the negative and positive plates, respectively.

The type of container employed depends upon service requirements. For stationary work and wherever the battery may be expected to receive proper care and attention, glass jars placed upon trays of sand are used, but for vehicle work in which the service is exceedingly severe, rubber jars properly sealed to prevent spillage of the electrolyte are employed.

One of the most extensively employed storage batteries for signal, telephone, telegraph and electric light and power work is the Chloride Accumulator. In this battery the Manchester type of positive plate is used. The grid; as shown in Fig. 1, is of a cast lead-antimony alloy and is provided with circular openings tapering slightly toward the center into which are forced, by hydraulic pressure, rosettes or buttons of soft lead which constitute the active portion of the plate. These rosettes, Figs. 2 and 3, are formed of strips of pure lead, corrugated transversely and rolled into a spiral. After being forced into place they are subjected to the forming process whereby the active material or lead peroxide is developed electro-chemically on the transverse surfaces. The expansive action of this forming process combined with the shape of the opening tends to lock the rosettes

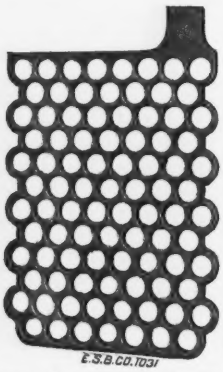


FIG. 1. MANCHESTER TYPE OF POSITIVE GRID

FIG. 2 SECTION OF MANCHESTER PLATE

FIG. 3. ROSETTES USED IN MANCHESTER PLATE

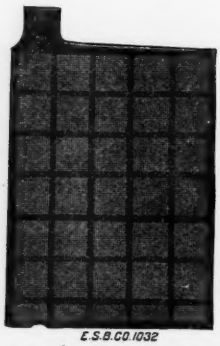


FIG. 4. BOX TYPE OF NEGATIVE PLATE

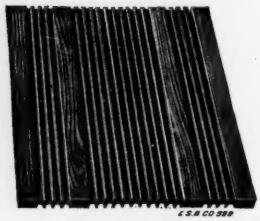


FIG. 5. TYPICAL WOOD SEPARATOR

securely into place and any further tendency to growth merely tightens the buttons in the grid.

As shown in Fig. 4, the negative plate consists of a grid formed of horizontal and vertical ribs spaced about 1 in. apart forming pockets closed at both sides with perforated sheet lead by which the active spongy lead is held in place. The elements are assembled and held securely together by plate straps carrying the necessary terminal posts and when placed in the container, negative and positive plates are separated by specially prepared wooden separators, grooved on both sides, with wide ribs on either vertical edge and at two intermediate points where the separator rests on the plate supports.

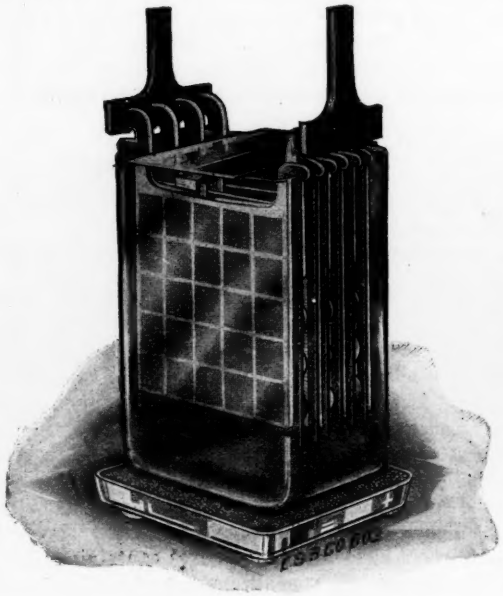


FIG. 6. CHLORIDE ACCUMULATOR WITH GLASS CELL

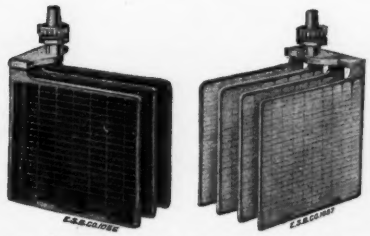


FIG. 7. POSITIVE AND NEGATIVE ELEMENTS, EXIDE BATTERY

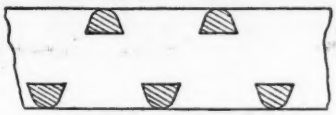


FIG. 8. SECTION OF EXIDE GRID

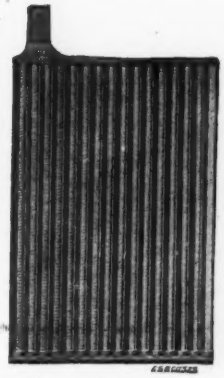


FIG. 9. POSITIVE PLATE OF IRONCLAD EXIDE CELL

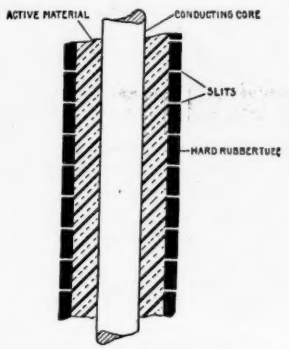


FIG. 10. LEAD-ALLOY RODS USED IN CONSTRUCTION OF POSITIVE PLATE, IRONCLAD EXIDE CELL

FIG. 11. SIDE VIEW OF LEAD-ALLOY ROD SHOWN IN SECTION IN FIG. 10

In mechanical construction, positive and negative plates of the Exide battery are similar. A grid made of a stiff lead alloy supports the active material which is in the form of a series of vertical strips held between the grid bars and locked in place by horizontal surface ribs staggered on opposite sides.

After the grids are cast they are filled with oxides of lead made into a paste which, like cement, sets in drying. The plates then go through an electro-chemical process which converts the material on the positive plates into brown peroxide of lead and that on the negative plates into gray, spongy lead. They are then grouped and those of like polarity joined by straps of hard lead alloy provided with posts to which the cell connections are made.

A somewhat unique form of positive plates and one particularly well adapted to batteries used in electric locomotive, baggage truck, auto truck and submarine service is that employed in the Ironclad Exide. Its construction may be readily understood from a study of Figs. 9, 10 and 11, and as may be seen from these illustrations, the grid is composed of a number of vertical parallel lead alloy rods united integrally to horizontal top and bottom frames, the former being provided with the usual conducting lug.

Each vertical rod forms a core, which is surrounded by a cylindrical pencil of oxide of lead enclosed in a hard rubber tube having a large number of horizontal slits, but sufficiently reinforced by leaving the exposed edge solid. Vertical ribs at these points and projecting at right angles to the face of the plate, serve not only to stiffen the tube but also act as insulating spacers, thus allowing the use of plain wood veneers.

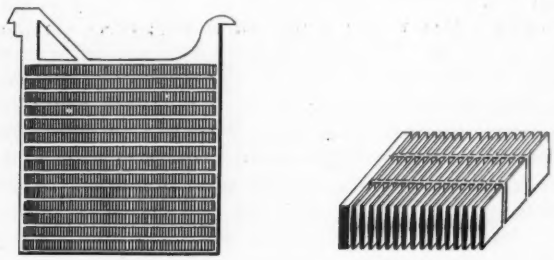


FIG. 12. A TUDOR POSITIVE AND SECTION

The negative plate is a modified form of that used in the Exide cell and the top and bottom are encased in rubber vulcanized in place.

Separators made of wood possessing exceptional toughness and the property of resisting the action of the electrolyte to a marked degree are used in these

batteries. And in order to prevent the registration of the grain in the same direction as the vertical ribs on the positive plates and the resulting tendency to split the wood, the separators are made with the grain horizontal.

Other forms of positive plates as used in lead-sulphuric acid batteries are shown in Figs. 12, 13 and 14. That in Fig. 12 is a cellular casting of pure lead, while those illustrated in Figs. 13 and 14 are made of sheet lead blanks with the surface area increased by plowing leaves in the first instance and by spinning with rotating circular discs in the latter.

Containers

For stationary service, the cell elements as shown in Fig. 6, are generally placed in open or covered glass jars which for the purpose of insulation rest on trays of sand; the completed battery is mounted on racks of treated wood, the number of tiers employed depending upon the size of the battery and available floor space.

Lead-lined tanks are also employed, especially in large light and power installations.

Portable batteries and those used for service in which spillage of the electrolyte is liable to occur are provided

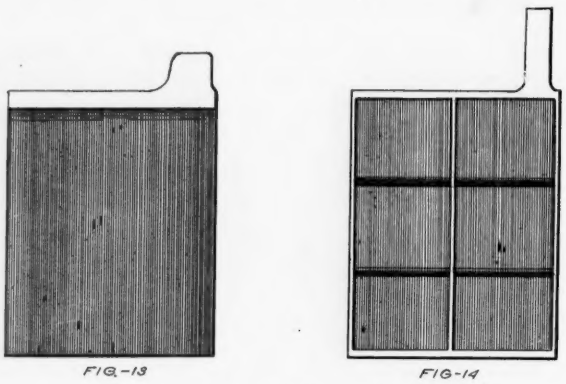


FIG. 13. WILLARD "PLOWED" PLATE
FIG. 14. GOULD "SPUN" PLATE

with cell jars of black rubber or other composition securely sealed within a wooden casing; access to the interior of the individual cells is through removable vent plugs provided for the purpose. The compound used in the body of the jar usually is not rich in rubber and its constituents harden with age. They become especially brittle if the battery is permitted to overheat on charge.

Various forms of combined vent and filling plugs are employed. A plug designed to prevent overfilling and slopping of the electrolyte and to provide a vent and spray trap which permits the escape of gas during charge, but catches and returns the acid spray to the cell, is illustrated in detail in Fig. 15. Air lock or barrel A, fits loosely in chamber D of the vent opening and engages with the top of the filling plug so that when this is removed barrel A must be turned into a position to close air passages B. This prevents overfilling the cell by trapping air in spaces C. When the vent plug is inserted a quarter turn tightens it in place by reason of the heavy interrupted thread, I, and at the same time turns barrel A so as to open air passages B. The vent plug is hollow and is provided with lateral openings G and one in the top at F, through which gas may escape; the interior chamber acts as a trap for the spray which is returned to the cell through opening H at the bottom.

Alkaline Batteries

In the Edison battery which differs materially from any one of the acid batteries in both mechanical construction and chemical re-action, the active materials consist of nickel peroxide for the positive plate and finely divided iron for the negative plate and the electrolyte is a 21 per cent solution of potassium hydrate in water combined with a small amount of lithium hydrate.

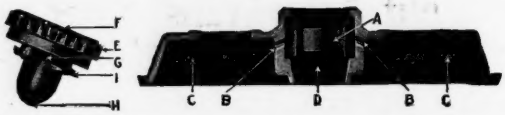


FIG. 15. CROSS SECTION OF CELL COVER WITH PLUG REMOVED

The positive plate is built up of a nickel plated, steel frame into which are pressed hollow, perforated sheet steel tubes filled with alternate layers of nickel hydrate and metallic nickel in very thin flakes. The tubes have spirally lapped joints and when filled have their ends pressed together in a way to permit ready mounting in the frames. Steel bands slipped over the tubes prevent expansion.

As shown in Fig. 16, the negative plate comprises a grid of nickeled steel with oblong openings into which are placed sheet steel pockets or boxes containing finely divided iron oxide and a small amount of oxide of mer-

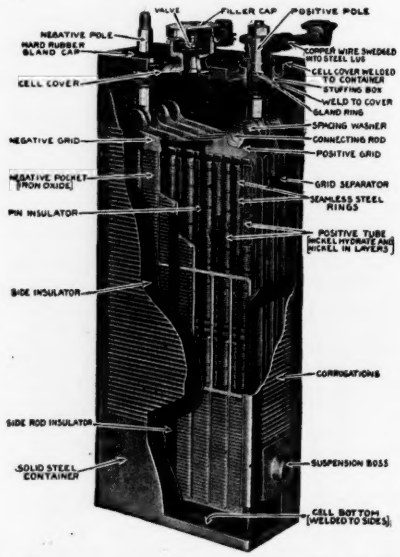


FIG. 16. SECTION OF EDISON ALKALINE BATTERY

cury, the latter to provide proper conductivity. These boxes are assembled in the grid and subjected to pressure to weld the joints and to corrugate their surfaces.

Cell terminals and containers are also of steel and all exposed metallic parts are heavily nickel plated. As in some of the acid batteries, separators and insulating parts are of rubber.

The chemical re-actions are quite complex and probably as yet not thoroughly understood. Essentially, however, it is known that during charge, oxidation of

the positive plate accompanied by a reduction of the negative plate occurs. During discharge this process is reversed.

Differing from the acid battery, the electrolyte used in the alkaline battery acts merely as a medium and does not enter into combination with the active material and the specific gravity instead of varying remains practically constant throughout periods of charge and discharge.

Induction Motor Starting Without Auto-Transformer

SMALL induction motors can be started by direct connection to full line potential. With motors of larger size, where the starting current under such condition is objectionable, and where an autostarter is undesirable, the motor can be started with the effect of a low voltage by bringing out from the windings six leads to a special star-delta starting switch. The connections for such a starting scheme are shown in the diagram.

Initial position gives a star connection, while the final or running position is in delta. This has the effect

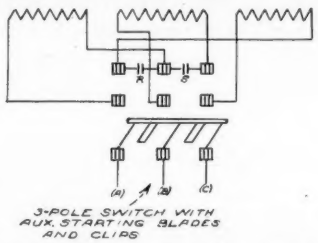


DIAGRAM OF CONNECTIONS SHOWING SPECIAL STARTING SWITCH

of placing on the motor at start about 58 per cent of full voltage and consequently reducing the starting torque ⅓ its normal value on full voltage. For this reason, the usefulness of this scheme is limited to cases where this low starting torque is sufficient to that of the load. Where a higher starting torque is required, the usual auto-transformer starter should be employed.—The Electric Journal.

IN AN ARTICLE on substitutes in German Electrical industry, Engineering of London states that zinc has been used in place of copper somewhat for transmission wire, and quite largely for bus bars and lugs. Aluminum and iron have been used for transmission lines, also alloys of aluminum with iron, with zinc, and with both these plus copper. For insulation, regenerated rubber, paper, and an artificial product of phenol and formaldehyde, called Faturan, has been used for wire and cables. Standards for current capacity and thickness of insulation have been established which answer the purpose reasonably well, though not equal to the standards formerly maintained.

Zinc was tried for transformer and machine windings and iron for commutators, but showed efficiency of only 40 to 60 per cent. Aluminum is now available, and shows efficiency of only 20 per cent below that of machines with all copper windings.

Connecticut Fuel Administrator Distributes Poster

MANY schemes have been used to arouse interest in the fuel saving campaign which has been thrust upon the country during the past few months, but one of the most effective is the poster reproduced herewith from The Locomotive, posted by the fuel administrator of Connecticut in all boiler rooms in his territory.

SAVE YOUR COAL TO FIRE THE KAISER

HERE'S HOW!

1. Keep boiler tubes clean from soot and scale both inside and outside.
2. Stop air leaks in boiler settings, flue doors, and cleaning holes.
3. Repair leaky steam pipes and valves.
4. Keep side and bridge walls free from ashes and clinkers.
5. Keep ash pit cleaned out.
6. Keep your fire thin as your draft allows.
7. Fire at short intervals and in small quantities.
8. Keep your fire bed level by spreading coal over thin spots.
9. Do not stir your fire unless necessary. To do so will cause clinkers.
10. Do not fire lumps larger than your fist.
11. Regulate draft with dampers not with ash pit doors.
12. Work your fire by your automatic damper, not your steam gauge.

THOMAS W. RUSSELL,
Connecticut Fuel Administrator

It emphasizes the importance of the fireman himself, the man who actually shovels the coal. It is printed in colors and shows Uncle Sam reaching out to the fireman and extending his message direct to the man with the shovel.

FOR EXPORT of high-pressure steam boilers to the United Kingdom, France, Italy or Belgium (except their colonies, possessions and protectorates), export license is required and the written approval of the Mission to the United States from the country to which export is intended must be secured. No material is to be bought nor labor done on the boiler until the export license has been granted. Approval must also be obtained from the United States War Industries Board, *after* the license has been granted, but *before* buying material or starting manufacture. Full details of procedure must be obtained from the War Trade Board, Washington, D. C.

Conservation of Ammonia---III

INVISIBLE LEAKAGE IN TANKS, COILS, CONDENSERS, COOLERS AND COMPRESSORS. HOW TO LOCATE. BY A. G. SOLOMON

INVISIBLE leakage of ammonia in a refrigerating plant is a hard proposition to deal with and it requires constant watchfulness on the part of the engineer. This unseen escaping of ammonia is the most troublesome leakage that occurs.

Such leakage may continue for days or even weeks before the defective part is located and repaired. When I say it may continue, I do not mean that the engineer can find any reasonable excuse for this condition.

There is no part of an ammonia system that cannot be tested for leakage and such tests must be made often.

The places where invisible leakage must be looked for are: Coils in ice or brine tanks; submerged ammonia condensers; water forecoolers of either the direct expansion or suction line type; double-pipe ammonia condensers; double or triple-pipe brine coolers; shell and tube type brine coolers, and from ammonia compressors into water jackets.

BRINE TANKS

THE CARE necessary to prevent leakage in ice-making tanks has already been discussed. Brine tanks are made somewhat on the plan of ice tanks, but are used for the cooling of the brine which is circulated in the operation of the brine circulating system as carried on in cold storage work. There is no danger of anything breaking a coil, so the only care necessary is to test the brine frequently for the presence of ammonia which may come from a leak which has developed in an unknown manner. As brine tanks contain a large amount of piping, the coils are high and close together. It is almost impossible to repair a leak in some parts of the tank, so the best way is to disconnect the defective coil at the inlet and outlet headers or manifolds and plug the openings. Then the coil can be lifted out, repaired and connected up when there is an opportunity. Or the leaking coil can simply be disconnected and left in the tank till the winter overhauling is done.

CONDENSERS

SUBMERGED ammonia condensers are not now in so general use as they were some years ago. A leak in one of the coils or manifolds of this type condenser is about as troublesome as any that can be encountered. The flowing water will absorb the ammonia from a large leak and the escaping ammonia will not be seen, heard or smelled. Litmus paper or Nessler's solution must be used to test the water for traces of ammonia.

To get a fair sample for testing, the circulating water must be shut off for at least 15 min. A greater length of time is still better if it is possible to run the machine and not have excessive condenser pressure.

The still water surrounding the coils will absorb the escaping ammonia and Nessler's solution will show the presence of a small leak if there is one.

If a leak is found to exist, the next step is to locate it. And the only way is to shut down the machine and empty the water out of the tank in which the coils are placed. Then use a sulphur stick and go over all parts till every leak is located.

If the leak should be in an inaccessible part of a coil, owing to the close centers necessary to build the condenser in the limited space, the coil must be disconnected at top and bottom and the headers plugged. Of course, this will reduce the condensing surface somewhat, but anything is better than a continual loss of ammonia.

Testing for leaks in the two types of water forecooler is done in the same way as in the submerged condenser.

The double-pipe ammonia condenser is a dangerous thing to operate, owing to the chances of great ammonia loss before the loss is even known to have begun. We all know that the double-pipe condenser consists of a pipe within a pipe with the water flowing through the inner pipe and the ammonia traveling in the space between the two.

As a rule, the water is used over a steam condenser or passed over a cooling tower after it has done its duty as a remover of heat in the ammonia condenser.

A leak can develop in one of the inner tubes and a large amount of ammonia will be lost even before a leak is suspected. For just this reason, this type condenser must be watched very closely. A large leak can be heard plainly as the ammonia will make a crackling sound when it strikes the water.

The habit of walking slowly around the condenser once every few hours is a good habit to form. But this only guards against the long duration of big leaks. It is the little leaks that are troublesome, as they cannot be heard or seen.

As the tubes in the double-pipe condenser must be cleaned by flushing or scraping at regular intervals, this can also be made close inspection time. Shut off the water both where it enters and leaves the coil and let it remain so for a half hour. Then open the drain and test a sample for the presence of ammonia. Even a very small leak will charge the confined water with enough ammonia to turn litmus paper pink.

COOLERS

LEAKAGE between the brine and ammonia spaces in coolers of the double-pipe and shell and tube types is hard to detect. The manner in which the coolers are connected to the circulating pump will determine the course of leakage; that is, whether ammonia passes into the brine or brine goes into the ammonia. Loss of ammonia will result in either case.

If the pump discharges through the cooler, the brine pressure is greater than the pressure of the ammonia and, if a leak should occur, the brine will be discharged into the ammonia; as any foreign matter causes decomposition, the effectiveness of the ammonia will be lowered.

Testing for such leakage must be done frequently and carefully.

Shell and tube type coolers are provided with a drain from the ammonia space as well as from the brine space. It is therefore an easy matter to draw off a sample of the liquid ammonia for testing. Draw out about a half pint and allow it to evaporate slowly by placing it in a

warm place. After the ammonia has evaporated, if there is still moisture remaining, this must be put in a shallow pan and placed on the steam cylinder. After the moisture is all gone, the tip of the tongue is touched to the pan and if the slightest trace of brine was in the ammonia a salty taste will be noticed. This testing of liquid direct from the cooler should be done only about once a month, as considerable ammonia is wasted each time, and that is what we are striving to prevent.

A simple but reliable test for leakage of brine into the ammonia in any type brine cooler is as follows: The ammonia with its very slight trace of brine will leave the cooler and pass through the compressor and then to the condenser. But the brine will be caught in the oil trap on the discharge line. When this trap is emptied the oil should be allowed to settle for several hours.

A pail made with a funnel-shaped bottom and having a small valve or pet cock at the lowest point is the proper vessel in which to settle the oil. If there are even a few drops of brine in the ammonia, it will settle to the bottom and will be entirely separated from the oil. This is now put in a shallow pan and the moisture evaporated and the tasting test resorted to. This may seem like a crude test to some, but it is sure, and a trial will convince.

If the cooler is on the suction side of the pump, the ammonia will go into the brine, if there is a leak. Leakage of this kind may continue for a long time, as it is hard to detect a small amount of ammonia in a large body of brine which is being continually circulated; and a brine cooler cannot be tested in the simple manner in which the double-pipe condenser is tested, for a freeze-up is likely to occur if the brine circulation is stopped for even a short time, unless the ammonia circulation is also stopped.

To test a brine cooler of either the double-pipe or shell and tube type, the expansion valve is first closed and the ammonia pumped out till there is very little liquid left. Then the suction valve is closed and also the inlet and outlet brine valves.

Before beginning to make this test, a pressure gage must be connected so as to show the ammonia pressure in the cooler.

Allow the cooler to remain in this dead state for an hour or more and then draw out a sample of the brine and test it with litmus paper or Nessler's solution. While the brine and ammonia circulation is stopped, watch the pressure gage, as the imprisoned ammonia may evaporate enough to cause a dangerous pressure and a blow-out may occur.

The places where leakage must be looked for are: Split pipe and defective gaskets in the double-pipe cooler; split tubes and tubes leaking at the ends where they are expanded into the tube sheets in the shell and tube type cooler.

One weak point in the shell cooler will be found at the tube ends which come in direct contact with the brine discharged from the pump. These tube ends will show wear and the thickness of the metal will become reduced so that the holding power is lessened and leakage is likely to start. Light rolling with the tube expander will help; but, if the metal is thin, this rolling cannot be depended on as a permanent repair job. New tubes will have to be put in.

If a few tube ends are noticed to be dangerously thin and new tubes are not on hand, it is better to take out the weak tubes and plug both the tube sheets than to take a chance on leakage.

In the operation of brine coolers of any type, the density or strength of the brine must be kept at such a point that the brine will not freeze quickly if the circulating pump should stop.

One more place where what may be classed with invisible leakage often occurs is into the water which is circulated through the jackets of the ammonia compressors. This leakage can be seen if the engineer will look carefully for it, but in the case of upright machines it is not unusual to have a valve bonnet or head gasket leak for days without any attempt being made to stop it.

A good plan is to drain the water jackets once a day and test for leakage with a sulphur stick. Many engineers will be surprised at the cloud of smoke that will roll up from the compressor when this test is made. It will not harm the machine a particle to operate with an empty water jacket for 5 or 10 min.; and no test should be considered too troublesome for the engineer to make when the saving of ammonia is the object.

How to Mix Substitutes

THE FOLLOWING TABLE showing the approximate percentages of barley or corn flours as substitutes which can be added to wheat flour for various purposes has been compiled by a large milling company, which gives as a general rule for the use of mixed flours, "a little more weighting and a little less rising":

	Per cent Barley or corn flour.
Gravies	100
Dusting flour	100
Wheat bread	15 to 25
Rye bread	15 to 25
Graham bread	15 to 25
Whole wheat bread	15 to 25
Bran bread	15 to 25
Raisin bread	15 to 25
Fruit bread	15 to 25
Nut bread	15 to 25
Brown bread	33
Coffee cake	15 to 25
Roll dough	15 to 25
Pie crust	25 to 50
Tea biscuit	20 to 40
Fried cakes	25 to 35
Crullers	25 to 35
Doughnuts	15 to 25
Griddlecakes	25 to 50
Waffles	20 to 40
Fritters	20 to 40
Muffins	25 to 50
Dark sheet cake	15 to 25
Dark cup cake	15 to 25
Dark cookies	15 to 25
Dumplings	25 to 50
Noodles	25 to 50
Puddings	25 to 50

Money Lost Up a Chimney

THIS handy and useful chart has been developed by the Uehling Instrument Co., 71 Broadway, New York. It is of unusual interest and value at the present time when the coal problem is so important, for it enables anyone to estimate quickly and closely the money now being lost up almost any chimney due to low CO_2.

Simply connect the percentage of CO_2 (shown in Column C) with the money now being spent per year for coal (shown in Column A) and the intersection of the connecting line with Column B immediately gives the dollars rolling out of the chimney in the form of heated gases.

Example: If $20,000 is spent per year for coal burned in a furnace whose average CO_2 registers 9.3 per cent, what is the approximate money lost up the chimney per year ?

Solution: Connect the $20,000 (Column A) with the 9.3 per cent (Column C) as indicated by the dotted line

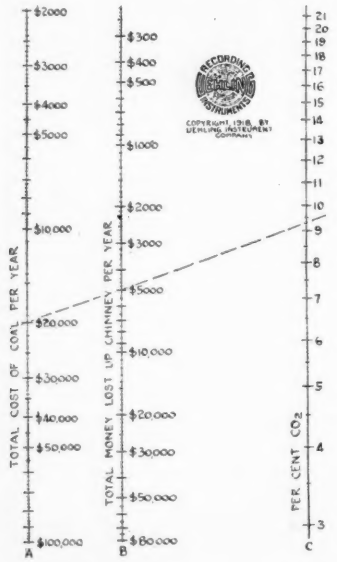


CHART FOR COMPUTING MONEY LOST UP A CHIMNEY

drawn across this chart, and the intersection with Column B shows the approximate yearly loss to be $5000.

The object of this chart is to show that a high percentage of CO_2 is most desirable. To be sure, even where the CO_2 is as high as 21 per cent, the theoretical maximum, there is a loss because in the average power plant the flue gases heating the boiler have a temperature as high as 500 or 600 deg. F. Loss, therefore, is inevitable unless a blower is used for exhausting the gases and some sort of interchange system is installed for either heating the feed water or preheating air and leading it under the grate.

It is significant that most of the large power plants of today have adopted CO_2 instruments that record automatically and continually. The reason for this is to keep constant tab on the efficiency of combustion. The recorder may be placed at any convenient distance from the boiler in the office of the chief engineer, owner, manager or superintendent, while an auxiliary CO_2 indicator is placed on the boiler front in full view of the fireman. The function of the indicator is to keep the fireman constantly informed as to the efficiency of his own work. This feature is most commendable.

Coal cannot be saved by a CO_2 machine alone. If no attention is paid to the indicator or recorder, the installation of such apparatus borders on foolishness. The records should be carefully watched and studied and adjustments should constantly be made in firing methods until the best percentage of CO_2 is obtained. After the best mark is reached, fluctuation of the CO_2 line below that mark to any great extent should not be allowed.

This chart is based on a flue gas temperature of 600 deg. F., and an outside air temperature of 60 deg. F. Where the flue gas temperature is higher, or the outside air temperature lower, the money loss will be correspondingly increased. On the other hand, with a higher outside air temperature and a lower flue gas temperature, the money loss is proportionately decreased. Further, in the construction of this chart, it has been assumed that the coal has a calorific value of 14,500 B.t.u. per lb. of combustible.

It may also be interesting to point out that where there is only 3 per cent of CO_2 in the flue gases, 76 per cent of the heat value of the coal passes up the chimney as waste under the conditions outlined above. It is impossible, however, for these gases to contain as low as 2 per cent, because it would require more than the original quantity of heat in the coal to heat the enormous surplus of air to a temperature of 600 deg. F.

WHILE THE CAMPAIGN for early ordering of coal has just begun, its effects are already being felt in increased production. The week ending April 27 showed the highest rate of production for 12 mo. past.

Loss of production from no orders is still heavy, however, in states west of the Mississippi River, and it is necessary that summer production be maintained at a maximum in that region if serious coal shortage next winter is to be avoided. The mines have ample capacity to take care of the fuel needs in the zones allotted to them, but must work at full capacity throughout the year.

Kansas and Missouri mines are showing a loss of production of 7.5 per cent, Oklahoma and Arkansas of 9.3 per cent, Iowa of 30.7 per cent, Pacific Coast states of 5.8 per cent and Rocky Mountain states of 12.3 per cent, all on account of lack of orders. Power plants in the western half of the country should bear this in mind, and place orders promptly for their winter's supply.

AN INDUSTRY which needs development for the interest of the country is the turning of potatoes into potato flake and potato flour. The process is not difficult, requires but a moderate investment in plant, promises good returns for the man engaged in it and occupation for expert mechanics who are needed to install and care for the machinery. The product will keep for years if put up in proper containers. Information may be had as to process and machinery from Dr. H. E. Horton, agricultural commissioner of the American Steel & Wire Co., Chicago, Ill.

Dry Air and Cold Steam*

RELATION OF VAPOR AND AIR IN SATURATED MIXTURE TO TEMPERATURES AND PRESSURE. BY FRANK RICHARDS

THE above title, which has been considered with care and is believed to be not inappropriate, may prove to be at first somewhat misleading, as the article does not deal with the precise conditions of which the normal reader will naturally first think.

The formula for computing the weight of a given volume of dry air at any temperature or pressure is extremely simple. The following gives the weight per cubic foot of dry air throughout the entire range of possible conditions:

$$W = 2.7093 \frac{P}{T}$$

in which W is the weight per cubic foot in pounds avoirdupois, P is the absolute pressure in pounds per square inch, and T is the absolute temperature, Fahrenheit, or the thermometer temperature plus 460 deg.

The above formula may, of course, be easily transformed as follows:

$$T = \frac{2.7093P}{W} \text{ and}$$

$$P = \frac{TW}{2.7093} \text{ or}$$

$$P = 0.3691\ (TW)$$

0.3691 being the reciprocal of 2.7093.

Table I, compiled by the aid of the above formula, gives the weight of 1000 cu. ft. of dry air for a variety of combinations of temperature and pressure. Tables have been published with minuter intervals and a greater range, but this is thought to be sufficient here. The diagram, Fig. 1, embodies the same data as in the table, but not for the entire range of temperatures. As all the lines in Fig. 1 are straight lines, this diagram may be indefinitely extended by the aid of a straightedge and pencil.

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These dry air data are generally the starting point in computations concerning performance and efficiency in compressed air practice, and there is more than a suggestion of unfairness or irrelevance in their employment. The ideal of efficiency, the 100 per cent of efficiency, in air compression is generally based, first, upon the assumption that absolutely dry air is used, and second,

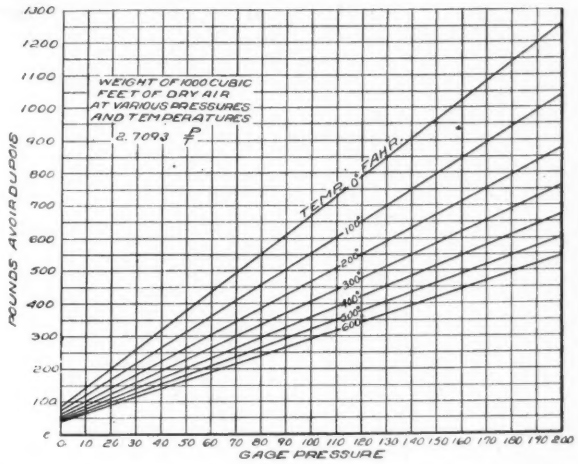

WEIGHT OF 1000 CUBIC FEET OF DRY AIR AT VARIOUS PRESSURES AND TEMPERATURES
2.7093 P/T
POUNDS AVOIRDUPOIS
DEGS. FAHR.
GAGE PRESSURE

FIG. 1. RELATION BETWEEN WEIGHT, TEMPERATURE AND PRESSURE OF DRY AIR

that the operation of compression is isothermal, or with no rise of air temperature from the beginning to the end of the operation. Now, it happens that both of these assumed conditions are practically impossible, and the computed percentages of accomplishment are compared not with a possible but an impossible 100.

TABLE I. WEIGHT OF 1000 CU. FT. OF DRY AIR AT VARIOUS PRESSURES AND TEMPERATURES

Temp. Fahr.	Gage Pressure, Pounds																	
	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	175	200
0	86.4	145.5	204.0	263.0	321.5	380.0	438.5	497.0	555.5	614.	672	731	790	849	908	968	1114	1260
10	84.6	142.5	199.5	256.8	314.5	372.0	429.2	486.3	543.3	600.6	658	716	774	832	880	947	1090	1233
20	82.8	139.5	195.5	251.6	307.1	364.5	420.5	477.0	533.9	589.0	645	701	757	813	869	922	1067	1208
30	81.1	136.6	191.6	246.5	301.5	357.0	412.1	467.2	522.1	577.1	632	687	742	797	852	908	1046	1184
40	79.5	133.8	187.6	241.5	295.4	350.3	403.8	457.6	511.4	565.2	619	673	727	781	835	890	1025	1161
50	78.0	131.0	183.9	236.7	290.5	343.2	396.0	448.7	501.4	554.1	607	660	713	766	819	873	1006	1139
60	76.4	128.3	180.3	232.3	284.0	336.2	388.2	440.2	492.	544.7	596	649	700	752	804	856	988	1116
70	75.0	126.0	177.0	228.0	279.1	330.2	380.8	431.6	482.4	533.2	584	635	686	737	788	839	967	1095
80	73.6	123.9	173.8	223.7	273.9	324.2	373.8	423.4	472.9	522.4	572	622	673	723	774	824	949	1074
90	72.3	121.8	170.7	219.5	268.8	318.2	367.0	415.4	463.9	512.2	561	611	660	709	759	809	932	1054
100	71.0	119.7	167.6	215.5	263.8	312.2	360.2	407.9	455.5	503.3	551	599	648	696	745	794	914	1035
110	69.8	117.6	164.5	211.5	259.3	307.0	354.2	401.1	448.1	495.0	542	589	637	685	732	780	899	1017
120	68.6	115.5	161.8	208.0	254.9	301.8	348.1	396.4	440.3	486.6	533	579	626	673	720	767	884	1001
130	67.4	113.5	159.0	204.5	250.5	296.6	341.6	392.4	429.6	477.0	524	570	616	662	708	754	869	984
140	66.8	111.5	156.5	201.5	246.5	291.5	336.4	381.3	426.2	471.1	516	561	606	651	696	742	855	968
150	65.2	109.6	154.1	198.5	242.5	286.5	330.8	375.1	419.3	463.6	508	552	596	640	685	730	841	953
200	60.3	101.4	142.7	184.0	224.8	265.5	305.4	347.3	388.2	429.1	470	511	552	592	633	674	776	879

For common manipulation there is no such thing as dry air; and how could there be when we remember that one of the most important and persistent functions of the atmosphere is the conveyance and distribution of water over the earth?

This work of the air is the most familiar topic of our daily conversation. We think of the air as driving

idly over the surface of our sphere and whenever it comes in contact with water picking up some of it, converting it into invisible vapor and flying along with it, until the conditions of pressure and temperature change sufficiently, and then dropping some portion of it, generally in the form of rain. In our familiar talks about the weather, when we believe a rainstorm impending we speak of the air as heavy, or laden with moisture.

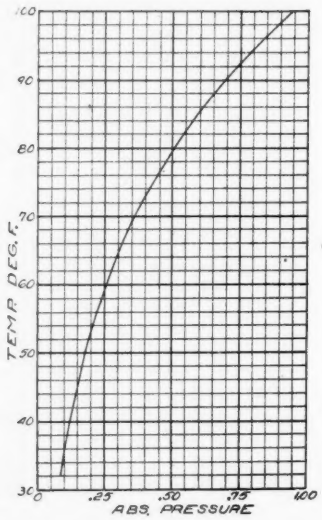


FIG. 2. VARIATION OF BOILING TEMPERATURE WITH PRESSURE AT LOW RANGES

But the paradox of it is that the more the air is laden with moisture, the greater the proportion of water vapor it carries, the lighter it is, volume for volume; and when, as we say, the air is saturated with moisture it is lightest of all.

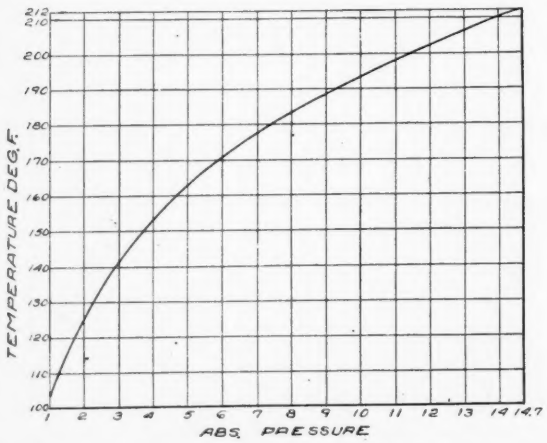


FIG. 3. VARIATION OF BOILING TEMPERATURE WITH PRESSURES FROM 1 TO 14.7 LB.

The simple fact is that the air does not pick up the water at all; but that the water, when it has the chance, forces itself in among the air molecules, diffusing itself equally all through the air and in the act displacing a portion of the air, so that any volume of moisture-laden air has not all the original volume of dry air in it, but the body becomes a mixture, the volume of air in it being reduced, or a portion of it crowded out, and the reduction of air volume being made up by an equivalent added volume of water vapor.

Here we come in sight of the cold steam of which the title of this article speaks. The water vapor mixed with the air is true steam, produced by boiling or evaporation; and our view of the actual conditions becomes immediately clearer if we agree to consider and to speak

TABLE II. DISTRIBUTION OF PRESSURE IN SATURATED MIXTURES OF AIR AND STEAM AT VARIOUS TEMPERATURES AND NORMAL ATMOSPHERIC PRESSURE OF 14.685 LB. (MERCURY COLUMN 29.921 IN.)

Temp. Fahr.	Abs. Steam Pres.	Abs. Air Pres.	Temp. Fahr.	Abs. Steam Pres.	Abs. Air Pres.
0	.0215	14.664	112	1.340	13.345
12	.0370	14.648	122	1.777	12.908
22	.0572	14.628	132	2.331	12.354
32	.0889	14.596	142	3.027	11.658
42	.1312	14.554	152	3.891	10.794
52	.1906	14.494	162	4.955	9.729
62	.2728	14.412	172	6.257	8.428
72	.3851	14.299	182	7.836	6.849
82	.5359	14.149	192	9.728	4.955
92	.7367	13.948	202	11.995	2.689
102	.9992	13.686	212	14.685	0.000

of any body of free air, dry air only in name, as a mixture of air and steam.

We speak familiarly of the boiling point of water as something fixed, but water is really as ready to boil at one temperature as at another if it can adjust itself to the pressure conditions. Here is a little list, picked from the steam table in Kent's pocket book, of the ordinary atmospheric temperatures and the absolute

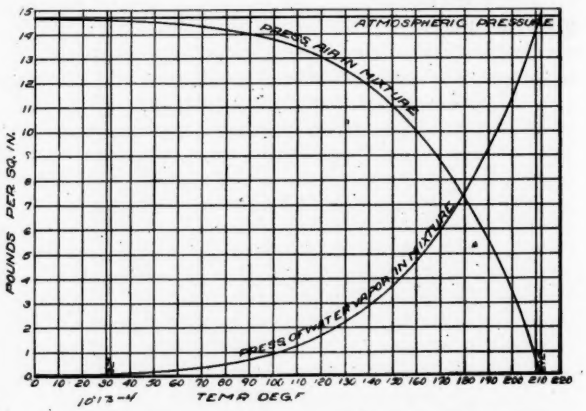


FIG. 4. PRESSURES OF AIR AND WATER IN SATURATED MIXTURES AT SEA LEVEL

pressures at which water boils at these several temperatures.

Temp. Deg. F.	Abs. Pressure	Temp. Deg. F.	Abs. Pressure
32	.089	70	.359
40	.122	80	.502
50	.176	90	.692
60	.254	100	.943

These data are given graphically in Fig. 2.

The following is a continuation of the preceding list with the absolute pressures in even pounds.

Abs. Pressure	Temp. Deg. F.	Abs. Pressure	Temp. Deg. F.
1	102	9	188
2	126	10	193
3	141	11	198
4	153	12	202
5	162	13	206
6	170	14	210
7	177	14.7	212
8	183		

Figure 3 embodies the same data.

In the mixture of dry air and cold, or low temperature, steam which we are considering, the steam retains its own characteristics. It, for instance, exercises its elastic force as usual, or produces the resultant pressure due to the temperature. The total pressure of the mixture, therefore, consists of the sum of this pressure added to the air pressure, and does not consist of the air pressure alone.

TABLE III. WEIGHT OF 1000 CU. FT. DRY AIR, WEIGHT OF 1000 CU. FT. SATURATED MIXTURE OF AIR AND WATER VAPOR, WEIGHT OF AIR IN 1000 CU. FT. OF SATURATED MIXTURE AND WEIGHT OF VAPOR IN 1000 CU. FT. OF MIXTURE AT NORMAL SEA LEVEL, ATMOSPHERIC PRESSURE (14.7 LB. ABS.) AND AT DIFFERENT TEMPERATURES, DEG. FAHRENHEIT

Temp. Fahr.	Dry Air	Saturated Mixture	Air in Mixture	Water Vapor in Mixture
0	86.3	86.3	86.2	.077
10	84.4	84.3	84.2	.119
20	82.7	82.6	82.4	.185
30	80.9	80.8	80.5	.279
32	80.7	80.5	80.2	.300
40	79.2	79.1	78.7	.408
50	77.7	77.5	76.9	.584
60	76.3	75.9	75.0	.823
70	74.9	74.2	73.0	1.145
80	73.5	72.5	70.9	1.572
90	72.2	70.8	68.8	2.130
100	70.9	69.1	66.3	2.848
110	69.7	67.3	63.5	3.770
120	68.5	65.5	60.5	4.983
130	67.3	63.5	57.1	6.384
140	66.1	61.3	53.1	8.188
150	65.0	59.0	48.5	10.396
160	64.0	56.4	43.2	13.080
170	63.0	53.6	36.9	16.317
180	62.0	50.4	30.2	21.198
190	61.0	46.9	22.1	24.797
200	60.2	43.1	12.9	30.233
210	59.2	38.8	2.	36.8
212	59.1	37.9	000.00	37.9

Table II gives the pressures of both the air and the cold steam, as we are calling it, at various temperatures all the way from 0 to 212 deg. F., the boiling point of water at sea-level atmospheric pressure. The diagram Fig. 4 shows this in an interesting way and should be worth studying. Beginning at zero Fahrenheit, the steam pressure or expansive force is very small, but continually increases with the rise in temperature, the air pressure decreasing correspondingly. At any point, measuring vertically, the sum of the steam pressure added to the air pressure—barring slight inaccuracies in the drawing of the curves—equals the atmospheric pressure.

It is to be remarked all along that the actual constituents of the mixtures tabulated are not the same all through, but are constantly different for the different temperatures. The quantities or weights of both air and steam in saturated mixtures are given in Table III, and are shown graphically in Fig. 5. Referring to the latter, curve A shows the weight of dry air at sea level and at different temperatures; B, the weights of saturated mixtures of air and cold steam; C, the weight of air in the mixture, and D the weight of steam in the mixture, the sum of C and D being always equal to B and always less than A. It is thought that this diagram can sufficiently speak for itself without further explanation.

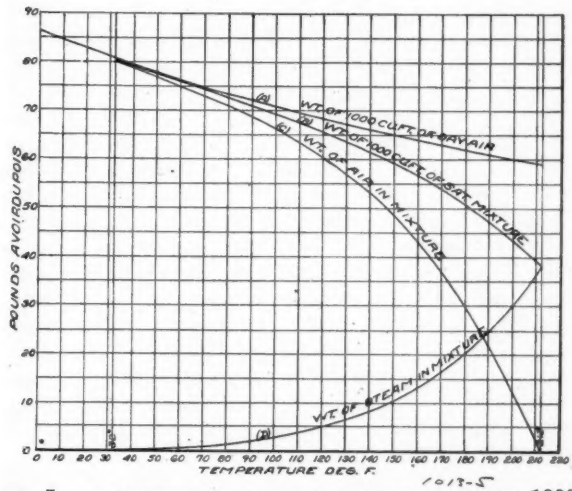

POUNDS AVOIRDUPOIS
TEMPERATURE DEG. F.
(A) WT. OF 1000 CU.FT. OF DRY AIR
(B) WT. OF 1000 CU.FT. OF SAT. MIXTURE
(C) WT. OF AIR IN MIXTURE
WT. OF STEAM IN MIXTURE
1017-5

FIG. 5. VARIATION IN WEIGHTS OF AIR AND VAPOR IN 1000 CU. FT. OF MIXTURE AT VARIOUS TEMPERATURES

The word "saturated" in the foregoing connection, suggesting a sponge saturated and heavy with water, is far from satisfactory and as misleading as possible, but nobody suggests anything better.

MEN OF experience as factory managers, superintendents and operating executives are needed by this corps for service abroad in repair and construction bases. The special branches desired are: factory construction, equipment and maintenance; sea-plane assembly; motor construction and repair; fine wood working; ignition; gasoline engine shop work; transportation by truck or automobile; canoe or light boat construction.

Requirements are that applicants shall have had experience at least as far as shop or factory superintendents, and preferably between 33 and 40 yr. of age. Officers will be commissioned as Ensign, or Lieutenant junior grade, and will be required for oversea duty not later than July 1.

Applications should be sent immediately to Military Training Camps Assn., 802 Consumers Building, Chicago, Ill., giving full account of experience and training, and names of three responsible business men to whom reference can be made.

Boiler Room Instruments*

WHAT INSTRUMENTS ARE USEFUL AND DESIRABLE IN THE BOILER ROOM AS AIDS IN SAVING COAL? BY E. G. BAILEY

THE answer to this question is: Meters that will actually *assist* the fireman to carry the load required of his boilers and at the same time obtain the maximum efficiency that is possible at that load. The old idea of having meters and recorders to "show him up" if he did not do his work well, when he usually did not know how to do it better, is entirely wrong.

The word "meter" is used here in its broad sense to include all instruments, pressure gages, thermometers, etc., down to a coal scale and even a wheelbarrow when they are used to obtain knowledge of the operating and efficiency conditions in a boiler plant.

In selecting meters, the principal object is to obtain knowledge of the boiler capacity and efficiency and also the individual losses, especially those which are controllable. To know accurately the losses is of much more importance than merely to know the efficiency, for efficiency can be increased only by reducing losses, and if one knows that the losses have been reduced, he is positive that the efficiency has been increased. The principal controllable losses in boiler operation are (1) combustible in ashes and refuse, (2) excess air, (3) unburned gas and (4) high temperature of flue gases. There are also other factors from an operating standpoint that are of importance, such as the steam pressure, superheat, rate of steam output from each boiler, evaporation per pound of coal, etc.

Meters are divided into four general types: Those which show (1) Condition, (2) Total, (3) Rate and (4) Relation.

Meters which show "condition" include pressure gages, thermometers, water level gages, etc., which in a boiler plant are used to measure steam and draft pressures; steam, flue gas and feed water temperatures; water level in the boiler and other similar factors. These meters may be either recording or indicating.

Meters which give "total" values or quantities include coal and ash weighing or measuring devices, also integrating meters for water, steam, etc. These are usually indicating only.

Meters which show "rate" can be either recording or indicating, and include boiler feed, steam flow, air flow, stoker speed, etc. They may also be combined with integrating meters of the second type.

The three foregoing types are those with which we are most familiar and they have been developed and their general use extended in the same order in which they are named, while from an operating standpoint the value of these different types is practically in their reverse order. For instance, it is better for a fireman to know the rate of steam output from each boiler continuously than to wait until the end of his shift and learn the average rate from a water meter that integrates total only.

The real valuable results from complete boiler tests, such as those made by Dr. Jacobus at Detroit some years ago, are not obtained until the many calculations involving averages and totals are made and the relations between the various factors is determined. In other words, the total evaporation or even the rate of evaporation gives no information whatever as to efficiency until we know how many B.t.u. were expended in producing this steam, or at least know how many B.t.u. were lost in making it. Time is an important factor in boiler operation and the fireman should know final results promptly and continuously. It is, therefore, very desirable to have meters of the fourth type, which indicate and record the "relation" between certain important factors as well as the condition, total and rate.

One of the important relations desired is that between rate of steam generation and rate at which fuel is burned. With liquid or gas fuels of uniform quality this is possible, but with coal, about the closest approach is the relation between a steam flow meter and tachometer on the stoker drive. The latter, however, is a very crude means of determining the rate at which the B.t.u. are supplied to the furnace, and this is the real factor desired. It is doubtful if this will be satisfactorily attained, in the near future at least, due to the varying amount of coal fed per revolution of the stoker shaft and the varying quality of the coal, as well as variations in the amount of coal on the grate.

There is another relation, however, that is analogous to the steam-fuel ratio that is readily obtained and of even greater value. It is the relation between the rate of steam flow from the boiler and the rate of air flow which supports combustion for the generation of this steam. Air is a fuel just as much as carbon or hydrogen, and the amount of air required to develop a given number of B.t.u. is practically independent of the character or quality of coal being used. In fact, there is only 6 per cent difference between the B.t.u. developed per pound of air used to burn carbon and natural gas. This is much closer than most people are able to maintain the excess air in coal fired furnaces today. Natural gas is mentioned in this comparison because it contains a higher percentage of available hydrogen than any other commercial fuel.

There is ample evidence available to show that the relation between the steam flow and air flow is of great value in assisting the fireman to maintain the most economical fuel bed and prevent undue losses in either excess air, or unburned gases. This relation is also of great assistance to the fireman in obtaining maximum capacity from his boilers, for he quickly learns that it is impossible to make steam without the proper supply of air and if the maximum air supply is equivalent to only 200 per cent boiler rating, then 200 per cent boiler rating is all he can get, unless he is willing to sacrifice efficiency and produce high percentages of unburned gases. Such a loss is plainly shown by this relation as a deficiency of air.

Another very important relation in boiler operation is that existing between flue gas temperature and rate of steam output. We have only to refer to data plotted by Mr. Azbe† to see that there is a wide difference between results obtained from various boilers in different plants. While this relation depends upon nature of baffling and other features of design, it is perfectly definite for any one design and a certain flue gas tem-

*From Advance Copy Discussion Coal Symposium, A. S. M. E., Worcester, June 6.

†Power Plant Efficiency, by Victor T. Azbe, Trans. A. S. M. E., Vol. 38, 1916, p. 722.

perature should exist for each rate of steam output. Any deviation from this indicates dirty heating surface or leaky baffles, provided the proper relation exists between the rate of steam flow and air flow. Either a decrease or increase in excess air from the most economical amount will result in an increase in flue gas temperature, except a very large percentage of excess air will reduce the temperature.

In boiler plant operation there are several other factors which should be combined to show continuously the relation existing between them for the benefit of the fireman or operating engineer, whereby they can get at the true conditions and their causes with as little mental effort and delay as possible. A meter which shows a relation is in reality an automatic calculating machine which takes two or more factors and produces a tangible result, which would otherwise require the reading of two or more instruments and reference to charts or tables.

The question often arises in selecting any of the four types of meters as to whether they should be indicating or recording. Some of the best power plant engineers were strongly in favor of indicating meters for boiler plant work a few years ago, but have now changed to be the strongest advocates for recorders. Practically the only argument that can be advanced in favor of indicating meters is lower initial cost and the lower cost of operation by elimination of charts.

Some of the many advantages of recording meters are: Permanent records to show conditions existing throughout the entire twenty-four hours; averages, totals and operating characteristics may be checked at any subsequent time, and of even more importance is the fact that it helps the fireman to see, not only the conditions at that instant, but also what the conditions have been immediately previous, and thereby ascertain whether they are changing, and if so, in which direction. This alone is of sufficient value to warrant the use of recording meters in practically every instance, providing they are located in the position where the man in charge of operation can readily see the chart record in detail. A water tender will do much better work when he has a recording feed water meter within sight, than if the recorder were located in the engine room.

The firemen and operating men have been up against a very hard proposition to obtain capacity and efficiency when working in the dark. They must have meters which serve as eyes whereby they can see through steam pipes and brick walls, so to speak, and actually know what is taking place. The meters that will give them the true pictures in the most realistic and concrete form are the most useful in saving coal.

Belt Drive Efficiency

By A. H. Greeley, Jr.

IF increased production is to be effected by Uncle Sam's manufacturers, constant efficiency of belt-driven machines must be maintained.

An increased output, together with a saving in power house items is possible only when a perfect belt condition is enacted and strictly maintained.

The efficiency of belt-driven machines will depend entirely upon a continued perfect arc of contact between the belt and the pulley, in accordance with the 180 deg. basis. Therefore, the amount of power transmitted from the power plant to the working machines will depend upon the state and material of the rubbing surfaces of the belt and pulley. Summarizing: It is not possible to gain maximum efficiency from belting unless the belts conform naturally (not by any force action) to the shape of the pulley, week in and week out. Spasmodic belt efficiency means nothing in effecting increased production.

Assuming that a good grade of leather belt is used, in order to maintain a constant contact of belt and pulley—there are three points to consider: (1) Alinement of belt and pulley; (2) surface condition of the belt; (3) innermost fibers of the belt. Each one of these are equally important factors in gaining full revenue from the working machine. There must be perfect alinement of belt and pulley so that a "full" contacting surface is possible. (It takes little time to create this condition.)

As power is transmitted by friction, the condition of the belt surfaces must be smooth, clean, void of hollows and ridges—air pockets and comparatively dry. Tests of Morin on iron pulleys showed that the co-efficiency of friction was 0.56 when dry, 0.36 when wet, 0.23 when greasy and 0.15 when oily. This proves that the most power is transmitted when the belt surface is comparatively dry. An oily, wet, or sticky surface decreases the coefficient of friction and consequent power.

Innermost fibers of the belt must be well lubricated by animal oils to make the belts soft and pliable, so that the belt conforms to the shape of the pulley, to allay heat of working fibers, to prevent the belt from cracking and to increase the life of the belt.

If the innermost fibers of the belt are not pliable, loss of power will result from turning the dry belt around the pulley—to say nothing of the lesser contact maintained or the life of the belt.

It is easily understood that belts by wear and individual factory conditions will readily dry out and will require proper lubrication at regular intervals. Greater efficiency will be received when a moderate application is made every seven days than a general "bath" every three or six months.

Mineral oils cannot be used on leather belting, as they not only rot the leather but decrease friction of the contacting belt and pulley surface, by making a wet surface. The correct oil for belts is a highly refined animal oil which will penetrate immediately, when "poured" on the belt, to the innermost fibers of the belt, and still leave a dry surface.

The cost of proper belt treatment is practically nothing when recorded on a profit and loss basis; but still, I find many who fail to appreciate the possibilities of efficient belt drives.

Let us assume that by proper belt treatment maximum efficiency is obtained; that an increase in transmitted power of 8 per cent is secured; tests show 3 to 28 per cent. Your power costs will not be increased; nor will your labor costs be affected, as you are compelled to make applications of various oils and greases throughout your mill—and a weekly application for belting can be consolidated with this factory routine. Another part of the labor side is the high cost to manufacturers of

belt repairs. Regular and systematic belt treatment will positively reduce belt repairs by at least 50 per cent.

If 8 per cent is received throughout the mill as an average increase in delivered power, why won't your output or production be increased by the same figure? If so, what would the value of your product produced then be in "dollars and cents"?

Your gain or net profit would be, in this particular case, 6 to 7 per cent. The cost of the oil would be trivial.

The majority of factories will be able to obtain a greater profit than 8 per cent from belt-drive efficiency. I know of some factories that have adopted this system which make a net profit of 25 per cent and their names can be obtained by request.

As these are days of conservation of any and all supplies, it behooves us to make every effort to eliminate waste and increase production.

Speed, efficiency and economy—that is the challenge to American industry today.

Above all, speed, but in modern industry no speed that has staying power is gained without efficiency.

Economy is needed, too, but it is economy of time, materials and labor.

Efficiency of belt drives creates speed, efficiency and economy.

Belt Slippage

By John Pierce

AS I am constantly seeking new ways in which to make my plant more profitable to my employers and to reduce any and all losses in the operation of my plant, I have read with much interest the discussion now being carried on in Power Plant Engineering as regards "belt slippage." And I note that each of the writers have had more or less of it, and have cured it, to their own satisfaction, in quite different ways. Mr. Schaphorst, I note, has evidently determined that any and all "slips" in his plant are going to be eliminated, and I am backing him with my best wishes. I'm sure he has cured the "pulley slippage" and feel sure that he will get the best of the old cowhide.

Over in Arkansas, in a little town of 2000 souls, they have a dry gas ice machine direct connected to a Corliss engine. The governor is belt driven, of course. I was sent there a few years ago to "work over" a part of their ammonia system, and after completing the job the engineer made ready for the season's run and started up. His engine developed a sort of gallop, and he decided that his governor belt was slipping, which it was. My instructions from my employers were that I was to offer no suggestions or give any advice to engineers wherever I might be working, except as regarded the particular work I was doing, unless directly called on by the engineer in charge, and then to assist him to the best of my ability.

So, while I was interested to the extent that any engineer would have been, I kept quiet and watched to see what he would do. First, he rubbed a little laundry soap on the belt, but this held for only a short time. Then he dug up a copy of Practical Engineer, remarking that he had read somewhere about "holes" in the pulley and wanted to see exactly what the other fellow had done. He found the article and, according to directions, was to drill certain sized holes, in the driven pulley in this case, as it was the one where slip occurred; but having no drills and being in a position where there were none to be borrowed he decided that he couldn't do the work.

After studying awhile he came to the conclusion that as the holes were for the purpose of "letting out the air" that caused the belt to slip, why a hole in either party of the slipping job would be all right. He had a belt punch, but no drill; what was simpler then than to make holes in the belt instead of the pulley. Besides, it was much easier. No sooner thought than done, and he proceeded to punch a row holes about 4 in. apart, with his largest punch, along the entire center line of the belt.

All this time I was laughing to myself and thinking how I'd "josh" him when he started up. But—the system worked and there was no slip at all more than there would naturally have been under first-class belt conditions, which would have been too small to calculate.

A brother engineer, being present from the light plant across the street, had been having similar troubles with the same cause—governor belt slipping; however, he confided, he didn't want to weaken his belt by punching the "danged thing" full of holes, and besides his boss would "holler" if he did. So he decided on a way of his own to remedy the trouble. I went over with him to watch and, perhaps, to laugh. Now, this fellow took a cold chisel, and pulling off the belt, proceeded to mark up the face of the driven pulley with a lot of cold chisel cuts, going over the pulley's entire face and making criss-cross, straight and zigzag marks. He then put on the belt and started up. I was again disappointed as regards my laugh, for the belt held and did not slip.

I've seen others drill holes in the pulley and cure the trouble, while some used a cork insertion and stopped the slip. I've seen a great many belts treated with "belt dressings" of various sorts, and they all helped, unless one got on too much, and then there were many, many "cuss" words used. In my own plants I've used a little of everything which came on the market. I've never been able to determine whether my belts were slipping because of "air cushions," because of "vacuum," or because of just "cussed orneriness."

I have in these latter years, however, found what I consider a cure for my belts. I do not use any dressing on my belts at all, nor do I drill holes in the pulley, use cork insertions, punch holes in the belt, or cold chisel my pulleys. I simply keep my belts *clean and pliable*, and just tight enough to do the work with the least possible friction on the bearings in order to get the work done. I use a little neatsfoot oil occasionally on the outside of the belt for the purpose of keeping them soft and pliable, and I put absolutely nothing on their face, carefully cleaning them occasionally with a rag moistened in turpentine and ammonia, drying any slight moisture on them before it penetrates the leather.

I clean carefully the pulleys, and all nearby points, of dirt, dust, oil, etc., in order that none might be drawn onto the speeding belt. And my bearings are not overloaded by friction on account of having to run too tight a belt, as 12 yr. run of my line shaft shows no perceptible wear as yet, and still my belts do not slip. This, I

think, is fair proof that regardless of whether we call it a "vacuum" or an "air cushion," the clean belt overcomes it and gives perfect results. More time spent in cleaning belts and pulleys and less to theorizing spells greater power and life to the belts, and more dividends to my employer.

Facts About the Liberty Engine

SO much of rumor has been printed about the Liberty Motor that was disheartening, that it is a pleasure to present to readers of Power Plant Engineering some real facts vouched for by the War Department about this aircraft engine.

The thought of the designers was to produce a light, powerful cylinder that could be produced in quantities, would wear well, give a large power for small weight and could be combined in sets of 2, 4, 6, 8 or 12, as desired, on bases of proper design.

Nothing new or radical was attempted. The cylinder followed the practice used in the German Mercedes, the English Rolls Royce, French Lorraine-Dietrich and Italian Isotta Fraschini, before the war and during the war. It has a steel inner shell, bored on the inside, turned on the outside and surrounded by a pressed-steel water jacket held in place by a method developed by long experiment by the Packard Motor Co. The bore is 5 in. and stroke 7 in. as in the Hall-Scott engine.

Valve cages are drop forgings welded into the cylinder head, the only departures being that the holding down flange is several inches above the end of the cylinder and the method of manufacture is unique, developed by the Ford Co.

Cam shaft and valve mechanism are placed above the cylinders with automatic lubrication to avoid wasting oil as devised by the Packard Co. The cam shaft drive is almost exactly the same as in the Hall-Scott engine and is the type used in the Mercedes, which has won fame on so many racing automobiles.

To save width and head resistance, the two sets of cylinders are set at an included angle of 45 deg. instead of 60 deg. as has been done in other 12-cylinder engines. This also gives a stronger crank case and reduces vibration.

Pistons are of Hall-Scott design and connecting rods have forked or straddle ends, two rods taking hold on one crankpin, as used in the French De Dion and the Cadillac engines. The crank shaft and case follow standard practice except as to oiling. One oil pump is used to keep the crank case empty, delivering to an outside reservoir. Another pump forces oil to the main crank shaft bearings and also through holes inside the crank checks to the crankpins.

Water is circulated by a Packard type pump. Fuel is supplied by means of a carburetor specially developed by the Zenith Co. for the Liberty engine.

Ignition is by a Delco system, specially designed to save weight and meet the conditions of firing 12 cylinders set at an angle of 45 deg. Double ignition is used, two spark plugs to each cylinder.

An 8-cylinder engine was first built and tested, but as advices from France indicated that the growing demand for large power would soon make this type obsolete, work was concentrated on the 12-cylinder model and that passed the 50-hr. test on Aug. 25, 1917. A committee of engineers from the Packard, Ford, Cadillac, Lincoln, Marmon and Trego companies met at frequent intervals and it is to this group that the final development of the Liberty engine is largely due.

The test showed "that very satisfactory service with a long life and high order of efficiency will be given by this power plant and that the design has passed from the experimental stage into the field of proven engines."

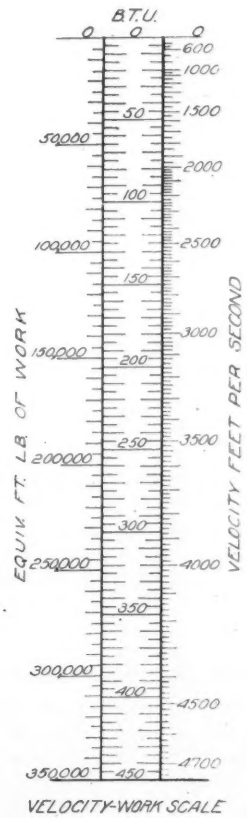
Cylinder forgings are now being produced at the rate of approximately 1700 a day.

Later tests have shown that a motor, after running 150 hr. continuously at full load, would without overhauling or adjustment, drive a battle plane at 120 mi. per hr. and operate perfectly.

Figures from a reliable source, but not given by the War Department are that the weight is slightly over 2 lb. per horsepower and the fuel consumption about 0.42 lb. per hp.-hr. at full load.

Correction Note

OUR ATTENTION has been called to an error which appeared on page 13 of the Jan. 1, 1918, issue. In the velocity-work scale to the right of the heat-entropy chart, the scale of equivalent foot-pounds of work should be multiplied by 10. In order that no mistake will be made in the future by use of this scale, the correct scale is printed herewith in such a size that it may be pasted over the incorrect scale in the Jan. 1 issue.



An Inexpensive Sawdust Chamber

CYCLONE SAWDUST CATCHERS are an excellent thing, but it is not always that we can induce "the powers that be" to go to that expense. Figure 1 shows a method that is inexpensive and reliable as far as it goes. It consists only of a box or small room, the larger the better. The inlet is shown at the top. The shavings pile up as illustrated and it must have a vent as shown. There is always a large amount of fine powder that is carried out with the air and it will settle in the chamber B. Clean-out doors in each department are shown. I have used this method for years with perfect satisfaction and can testify that with reasonable care in cleaning out there will be no dust flying around the yard. The vent should be ample size, because this will make the outgoing air slow in velocity and not liable to carry dust with it.

Another ingenious and economical thing is shown in Fig. 2 for a bearing of any size. This consists of a simple chain such as is used in a flush box and made endless, and is simply hung over the end of the shaft and goes down into a pan of oil. A little fiber board strip, A, is attached to the bearing and simply guides

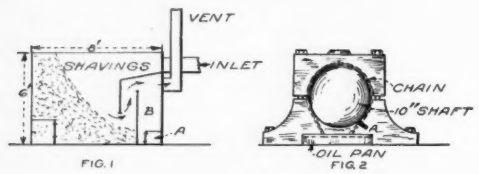


FIG. 1. EASILY MADE CYCLONE
FIG. 2. CHAIN OIL BEARING WITH FIBER GUIDE

the chain from running off. I have had this device on a 10-in. shaft bearing of a 20 by 42-in. engine and it gives the most excellent results and never fails, with no care whatever except to put a pint of oil in the pan about once in 6 mo., and even this is not absolutely necessary. The bearing box is 14 in. long. Capillary attraction carries the oil in on the shaft and there need be no oil cup on top of bearing.

A. C. WALDRON.

Heat Loss Through Boiler Settings

THE FOLLOWING tests were made by the writer on a 300-hp. Stirling boiler, to determine the heat lost through the brick setting.

The test was made with the setting walls uncovered, and also through ½ in. and 1 in. of asbestos.

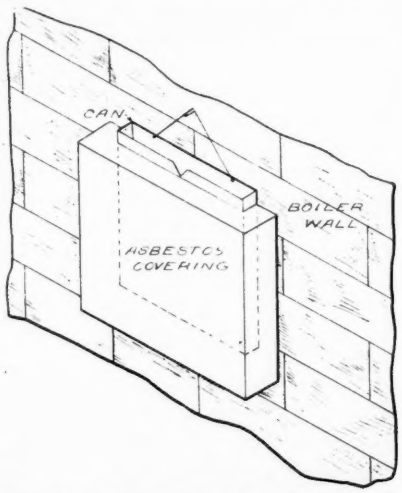
A can was made about 6 by 6 in. square and 0.8 in. thick, of tin, and covered with about 1 in. of asbestos, except one side of the can, which was left uncovered, as shown in the drawing. One pound of water of the same temperature as the boiler room, was put in the can. This water covered 0.23 sq. ft. of the side of the can in contact with the boiler wall, the can being suspended on the rear wall of the setting. Several tests were made and checked with the following results, the B.t.u. loss through the setting being determined by the rise in temperature of the water.

TEST NO. 1

Can in contact with the rear boiler wall.
Temperature of boiler room, 95 deg. F.
Temperature of flue gas, 500 deg. F.
Original temperature of water, 95 deg. F.
Final temperature of water, 118 deg. F.
Rise in water temperature in 30 min., 23 deg. F.

TEST NO. 2

With ½ in. of asbestos between can and boiler wall.
Temperature of boiler room, 95 deg. F.



METHOD OF TESTING FOR BOILER WALL RADIATION

Temperature of flue gas, 500 deg. F.
Original temperature of water, 95 deg. F.
Final temperature of water, 101 deg. F.
Rise in water temperature in 30 min., 6 deg. F.

TEST NO. 3

With 1 in. of asbestos between can and boiler wall.
Temperature of boiler room, 94 deg. F.
Temperature of flue gas, 500 deg. F.
Original temperature of water, 94 deg. F.
Final temperature of water, 98 deg. F.
Rise in temperature of water in 30 min., 4 deg. F.

A test was made on the side wall opposite the furnace, which gave practically the same results. The side

walls being 18 in. thick and lined with fire brick. The rear walls being 12 in. thick of red brick.

From test No. 1, the B.t.u. loss per square foot per hour per degree temperature difference, through 12-in. wall = 200 ÷ (500 — 95) = 0.5 B.t.u. approx. The total B.t.u. loss per square foot per hour, as shown by this test = (23 × 2) ÷ 0.23 = 200 B.t.u.

From test No. 2, the total loss per square foot per hour = (6 × 2) ÷ 0.23 = 52.17 B.t.u.

From test No. 3, this loss = (4 × 2) ÷ 0.23 = 34.78 B.t.u.

The total surface of this boiler which could be covered is 1000 sq. ft. This does not include the front.

The total loss in B.t.u. for uncovered setting = 200 × 1000 = 200,000.

With ½-in. covering, this loss = 52.17 × 1000 = 52,170 B.t.u.

With 1-in. covering, the loss will be 34.78 × 1000 = 34,780 B.t.u. per hr.

The preventable loss with ½-in. covering = 200,000 — 52,170 = 147,830 B.t.u.

The preventable loss with 1-in. covering = 200,000 — 34,780 = 167,220 B.t.u. an hr.

With coal having 12,000 B.t.u. per lb., this would be 167,220 ÷ 12,000 = 14 lb. of coal an hour approximately.

In a plant running 24 hr. a day, this would amount to about 5 tons a month, or 60 tons a year. With coal at $3 a ton, it would be $180 a year.

The present price of 82 per cent asbestos cement is $3 per 100 lb.; 100 lb. will cover about 24 sq. ft. 1 in. thick; this would be 12½ c. per sq. ft., or a total of $125 to cover the boiler.

It is the writer's opinion that the saving would be greater than shown by the tests, due to the fact that the covering would prevent air leaks through the setting. The writer intends to cover this boiler as soon as possible, and note the results.

These tests were made on the basis that 1 B.t.u. is required to raise 1 lb. of water 1 deg. F.

R. L. Mossman.

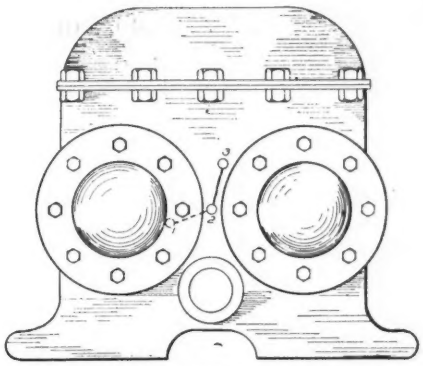
Repairs After a Flood

During the recent flood in the Ohio Valley, I lost four pumps and one boiler by freezing. I hear somebody say "poor management," but he wasn't here with 7 ft. of ice in the engine room. I repaired one with a crack extending from barrel to center, as shown, by drilling and tapping and using two ⅜-in. bolts and one ½-in. bolt. After screwing them in as tight as possible I cut them off and riveted the projecting end, and the pump is doing fine.

One of our stacks broke off during a heavy storm and only about half was left. In order to get going and give the boiler necessary draft, I made a steam blower, putting it at the base of the stack, using ¾-in. pipe, having it drawn down to ⅜-in. Much of the success of a blower depends on a good job of drawing out the nozzle. The blower, to be effective, must be set in the center of the stack. It would be interesting to know how many feet of stack is necessary to equal in natural draft the draft created by the blower. Having no instruments here, I am unable to give it.

While running an 8-in. discharge line to the river, we broke a set of chain tongs. One of the men took a length of chain 6 ft. or so with a hook at one end and using a 2 by 4 for a lever, we completed the job and it was tight. Simply hook chain over a fitting or loop around pipe, slip lever in and there is a first-class chain tong.

In regard to discussion on commutator trouble, I agree with the engineer advocating undercutting. I have one 50-kw. 220-v. machine which was turned down and in two weeks went bad. A further turning and a



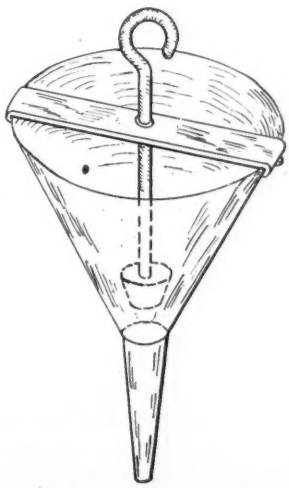
CRACKED PUMP CASTING AND REPAIR

very light undercutting was next tried. The machine runs fine, no sparking or burning, and we frequently get 50 to 60 per cent of the load all at once.

J. C. Lee.

Funnel with Stopper

Who has not, when filling some container with the aid of a funnel, spilled the oil, or other liquid on account of not knowing when it was full. In nine cases out of ten, the usual procedure is to stick the funnel in the neck of the container and merrily pour away until the liquid



FUNNEL FITTED WITH CORK TO PREVENT WASTE

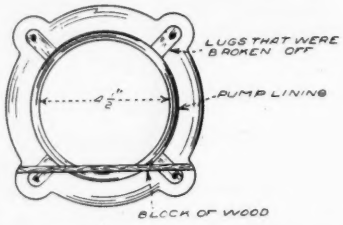
starts to fill up the funnel, then frantically try to lift the funnel and its contents out, and stick a finger over the spout to save it from being spilled.

To overcome this disagreeable phase of trouble, one of the boys hit upon a scheme shown in the sketch.

It is very simple and does the stunt. A narrow strap is secured across the top of the funnel, and a hole drilled in the center. A bit of rod is threaded on one end like a screw and the other end bent into an eye. A cork that will easily enter and fill the inside diameter of the upper end of the funnel spout is screwed onto the rod, as shown. C. N. W.

Emergency Pump Repair

IN THE PLANT of which I have charge, we have a 7½ by 4½ by 10-in. duplex pump for pumping cold water into a tank that supplies our heaters. This water is taken from a small lake near the plant and seems to have a corrosive effect on the cast iron of the pump, especially around the cap screws that hold the brass lining in the water end, by eating away the threads so that the screws would not hold the lining in place. The pump failed to work, and after taking the head off the water end, we found the lining loose, all the screws out and the four lugs where the screws went through were



END OF PUMP WHERE BLOCK OF WOOD WAS PLACED

broken off, so there was no way of holding the lining to its place and we could not use the pump. Needing the pump badly, we had to find some way out of the difficulty. By placing a block of wood about 6 in. long, ⅞ in. thick and 1/32 in. wider than the distance between the flange on the lining when it was in place, and the head for the water end, in between the lining and head and pulling the head up solid, we were able to use the pump and keep up the supply of water. O. V. B.

Combined Gas and Coal Firing

THE SHORTAGE of coal has caused many engineers to give renewed attention to some of the schemes for economizing fuel which have been suggested from time to time, but which, either by reason of their inefficiency or of their comparative costliness have not been adopted. They have sought in the former case, to improve the heat value, and in the latter to see how the cost of working under present conditions compares with that of using other fuels at today's prices, bearing in mind that a method which was inefficient or costly at pre-war rates may now be a most economical method to adopt.

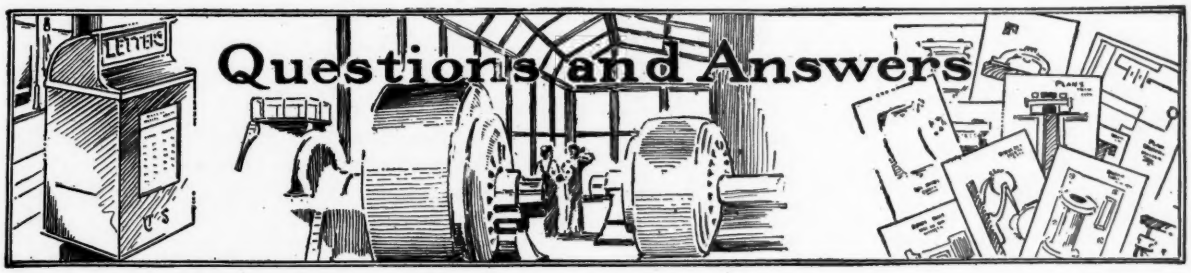
Those engineers who are dealing with steam plants will be interested in the recent experiments which have been carried out in firing boilers with a combination of ordinary gas and moderate grade coal. The boiler plant of one of the largest electric traction and lighting power supply companies in existence was lent for the purpose of making the tests, and the reason they were made was that recent large extensions had been made to the demands on the station, and it was considered advisable to see whether anything could be done to improve the present efficiency of the boilers before putting in additional plant.

The gas was not burned in conjunction with the coal throughout the whole of the 24 hr., but it was used more or less as a standby to meet sudden demands, and also as an auxiliary during the comparatively limited time when the new load mentioned came in on the top of the existing peak. For this reason, the tests will be more than ordinarily interesting to those engineers who have to deal with a lighting load which will for certain hours coincide with the power load during the winter months. The coal used was, as has been said, of moderate quality, and the gas was a by-product of a neighboring coke oven.

A number of experiments were carried out to ascertain the best method in which the gas could be used. It was first tried alone, but the result of the tests, which were both too numerous and too lengthy to describe in detail, was to demonstrate the cheapness and efficiency of combined gas and coal firing. It may be mentioned, however, that when gas by itself was tried, in the furnaces, fairly good results were obtained when broken firebrick was spread evenly and fairly thickly over the firebars. It was found that the method worked well, but lacked flexibility, and it was far from easy to force the boilers whenever it was necessary to meet an overload. What is known as a dutch oven was then tried on a boiler, according to a description of the initial tests, which increased the rating considerably. The results obtained were not sufficiently good to justify the adoption of the system, and further tests were asked for and duly carried out.

The scheme finally adopted was the employment of a number of jets or burners which drove gas down onto the burning coal, which was being continually fed forward by a chain grate. With a moderate expenditure of gas it was found that the output of the boiler was increased by nearly 33⅓ per cent above the figure obtained by coal alone. The flue gas was hotter than when the boiler was fired without the gas auxiliary, but only slightly so; the percentage of unburned coal in the ash was also rather higher. Both these slight fallings off in the efficiency of the coal-fired part of the furnace were probably due to an insufficient supply of air, as curiously no direct tests appear to have been made with a view to ascertaining how far the efficiency of the system could be improved by varying the air supply. The efficiency of the boiler using the combined gas fuels was higher than with coal alone; but although the flexibility was not so great, and other reasons militated against its employment in that manner, the use of gas alone in the boiler gave a better efficiency than with either coal or gas and coal combined.

The actual economies of the situation were naturally controlled by the comparative costs of gas and coal, but as the price of the latter is steadily rising while the supply is becoming just as steadily shorter, it may be well that, even if today it is not quite so cheap to use combined gas and coal, as it is to use coal alone, in the near future combined firing of the kind described will show a considerable saving over ordinary methods in cases where the gas, as in the example cited, is a by-product. MARK MEREDITH.



Ceiling Condensation; Engine Vibration

I HAD a great deal of trouble with the condensation on our engine and boiler room ceiling during the past winter, and have had this up several times with different parties, but up to the present time have not had any suggestion that would be of any benefit to me.

We have a corrugated iron ceiling with a thin asbestos covering over it; our engine and boiler room is 48 ft. by 90 ft., and we have one suggestion that I have tried, which is triple boiled linseed oil put on with a brush, and a heavy coat of ground cork; three applications of this. Now this seems as if it would do the trick; but it seems to me that this is too big a job to put it on, and also the installation of a ceiling might be able to take care of this condensation by having a dead air space. I thought, however, that readers might have some suggestion that would not be too expensive to carry out, as both of these plans that I have mentioned would be quite expensive.

We have installed a high-speed uniflow engine, 300 r.p.m., and we are getting a great deal of vibration; in fact, the vibration can be felt several blocks away from the plant, and in some localities, it vibrates so much that it can be noticed very distinctly. The soil is of a quicksand makeup with very little gravel. I understand, however, that in the foundation of this engine, there was driven a good many piling, and then good depth of concrete, for the foundation; but I hope that some reader will be able to make some suggestion that might be a benefit to us in eliminating this vibration. Do you think that counter-balancing our flywheel opposite the crank would have any effect on it? F. L. W.

Peculiar Generator Behavior

I HAVE a 7.5-kw. direct-current generator on which we burned out a bearing. As a result, the armature had to be removed and rewound.

After having this work done, I replaced the bearing and belted up the machine. It would, however, not generate, although I shifted the brushes, examined all connections and, in fact, did everything I could think of to make it pick up.

I then passed current from another machine through the field coils, running the voltage up to 60 v. This appeared to help matters a trifle, so I let the two machines run that way for about 10 min., after which I disconnected them and found the defective machine capable of maintaining its voltage.

After turning on a few lamps, the voltage would increase and after it reached 110 v. I tried to hold it there by means of the rheostat, but could not do so as it would either go back to zero or climb up so high as to cause the armature to smoke.

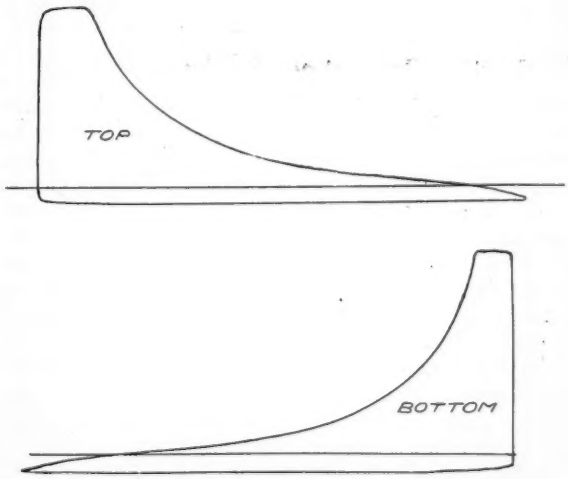
I then put full load into it, which, however, it refused to carry and it was not until I had but four or five lamps on that the voltage would be maintained and then again only so high as to cause more smoking.

I would like to know if any of the readers of Power Plant Engineering have had similar trouble and if so what they did to remedy it. E. A. F.

Blowing Engine Cards for Criticism

SHOWN IN the accompanying illustrations are two cards taken from a 44 by 60-in. Allis-Chalmers blowing engine operating at a speed of 36 r.p.m. The air cylinder has a diameter of 80 in. and works against a pressure of 9 lb.

Will the readers of Power Plant Engineering kindly examine these cards and offer criticisms and suggestions toward improvements?



HOW MAY THESE CARDS BE FURTHER IMPROVED?

We have had considerable trouble getting cards satisfactory to ourselves and although we feel these are almost as nearly perfect as can be obtained, we desire the opinions of others. E. L. S.

Removing Carbon Deposits

THE TWO-STAGE direct-connected air compressor used in connection with our 280-hp. Allis-Chalmers horizontal four-cylinder oil engine has given us considerable trouble of late.

Unless we change the valves weekly, the machine develops a very severe intermittent pound, first as the valves and cylinder heads become clogged with carbon and then as the piston forces this carbon out through the discharge. It then runs quietly for a while, only to

start pounding again as soon as another deposit is formed, and the only thing to do in order to better matters is to put in a new set of valves.

We have tried several grades of oil and now are using one of considerable high fire test.

A blow down valve between the two stages is employed to keep out water and carbon.

How would it do to inject at times a small amount of coal oil with the air charge? This would undoubtedly keep the valves clean, but our superintendent is afraid to have us try it on account of the danger of explosion.

I have used it on small compressors with satisfactory results; but before using it on this one, I wish to hear from some of the readers of Power Plant Engineering who have tried it on compressors such as that mentioned above. M. E. W.

Cleaning Boiler Tubes with Water

We have experimented in the cleaning of boiler tubes of soot by the use of warm water at a pressure of 50 lb. This cleans the tubes perfectly and in but one-half the time required by the old hand scraping method. We have noticed no detrimental effects on the brick work or any other portion of the boilers, but before continuing this practice we would, however, like to know if there are any other plants in which the outside of the tubes are washed and whether there is any danger attending this procedure. R. E. D.

Starting Connections for Small Motors

Will a 7½-hp., three-phase, 220-v. induction motor start satisfactorily direct off the line or through a common switch, or will a compensator have to be installed in the line for satisfactory results? V. K. S.

A. If a slight drop of voltage is not objectionable, then we would suggest that you start your 7½-hp. motor by means of an ordinary knife switch; but if, on the other hand, the circuit supplying this motor also serves lighting circuits, it may be that such a drop in voltage would be objectionable.

Under such conditions, of course, it would be desirable to use a compensator. As far as the motor is concerned, however, you are perfectly safe in starting it by simply throwing it directly onto the line.

Electric Machine Operation Questions

When changing a motor from one source of supply to another, can this be done by the quick throw of a double-throw switch or is it better to stop the motor, change your source of supply and then start the motor again? Of course, the latter procedure requires the expenditure of more or less time, but it is always better to be safe than sorry.

2. On some generators, when an armature coil becomes short-circuited it is possible to continue the machine in operation by merely cutting the coil leads and connecting the two commutator bars thus disconnected by a short length of wire. In others, however, I have found it necessary in order to prevent excessive heating of the disconnected coil to remove this entirely. Why?

3. How may one best clean out the oil box of electrical machines such as motors, generators, etc.?

J. B. D.

Answers

The answer to your first question may be "yes" and still may be "no"—depending upon conditions.

If the change-over can be made exceedingly quickly—by that we mean within some fractional part of a second—it would not be necessary first to shut down your motors, then make the change, then start them again; but if such a change cannot be made in a comparatively short period of time, it is desirable to shut down your motors, then make the change and then start the motors again. This is especially true in the case of a system carrying a heavy load.

2. You have perhaps noticed that it was only in the case of coils which were made up of a great number of turns of fine wire that it was necessary to remove them when cutting out such a coil. You will readily understand that in the case of an armature, the coils of which consist of a small number of turns—perhaps two or four— of heavy wire, the electromotive force introduced in such a coil is comparatively small in comparison to that introduced in a coil made up of a great number of turns.

3. For the cleaning out of oil boxes such as used on motors, generators, or, in fact, any other machine, we would suggest flushing with kerosene or gasoline.

Low-Pressure Turbine Operation Trouble

We have a 1580-kv.a. low-pressure turbo-generating set of Westinghouse make operating condensing in connection with a Leblanc jet condenser. Lately our low-pressure steam has failed us while carrying full load, which is, of course, compensated for by the operation of the high-pressure valve through the oil relay system. However, the turbine slows down, and as a consequence the resulting reduction in voltage and frequency reacts on the motor-driven water and air pump, causing the vacuum to rise and fall as high-pressure steam is admitted to the turbine bringing it up to speed again, but dropping back before the governor can check it again after cutting off the high-pressure steam.

What I would like to know is, if the pressure was taken off the pilot valve and relay piston, causing it to rise and carry main valve to full open position, could the speed be regulated to carry an even vacuum with the high-pressure steam hand regulated?

R. A. F.

A. In answer to your question, we would say if the turbine reduces in speed as much as several per cent in going from low-pressure to high-pressure steam, it is because the valve gear is not properly adjusted, or water is allowed to accumulate in boxes in the high-pressure steam line and is forced through into the low-pressure line, and possibly into the turbine when the high-pressure valve opens. The high-pressure steam line must be kept thoroughly drained at all times, and the valve gear adjusted so that the high-pressure valve will start to open when the pressure on the turbine side of the low-pressure inlet valve is approximately ½ lb. lower than

the pressure in the steam header at the turbine throttle valve. If especially close regulation is required, the high-pressure governor valve may be discontinued and the high-pressure steam admitted to the low-pressure steam header through an automatic pressure reducing valve, adjusted so as to maintain a constant pressure in the low-pressure steam line sufficient to take care of the maximum load on the turbine. With this arrangement there will be no drop in speed whatever in changing from low-pressure to high-pressure steam.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.,
J. F. JOHNSON, ENGINEER TURBINE DEPT.

Belt Transmission Problem

I WISH TO OPERATE an electric generator by means of a counter shaft, the driving pulley on which has a diameter of 26 in.; the generator carries a 4-in. pulley and is supposed to operate at a speed of 1900 r.p.m. The pulley on the main shaft which will drive that on the counter shaft is 32 in. in diameter and has a speed of 84 r.p.m. To what size of pulley should this line shaft pulley be belted in order to run the generator at its rated speed?

What size belt should I use on the generator pulley?
M. G. M.

A. With 4-in. pulley on the generator and 26-in. pulley on the counter shaft, the speed ratio will be about 6.5. Your total speed ratio between the generator and the line shaft is 1900 divided by 84, or 22.6. Dividing this by 6.5 gives 3.48 as the speed ratio between the counter shaft and the line shaft. With 32-in. coupling, the pulley on the line shaft would be 32 divided by 3.48, or 9.18.

It will be necessary to allow for a certain amount of slip, and if we allow for about 5 per cent slip, this would make your small pulley on the counter shaft 8.5 in. It would be better to have this allowance so that you would have the generator running at a little above, rather than under, speed, as you can cut down the voltage by a field rheostat, whereas if you are under speed, there will be no way of bringing up the voltage.

We cannot tell you what width of belt to use, as you do not say what the capacity of your generator is to be; but that will be taken care of, practically, by the width of the pulley on the generator.

Voltage Selection; Motor Questions

WE FIGURE on installing a 50-kw. compound wound direct-current generator for electric light and power service. Could we use a 250-v. machine and get as good or better results as with one of 110 or 125 v.?

We have one hundred 120-v. lamps and I plan on connecting these in groups of two in series across the 250-v. line.

Would there be any advantage in using a rheostat in connection with these lamps to reduce the voltage sufficiently to eliminate the series scheme?

Can either a series, shunt or compound-wound motor be operated by means of a compound-wound generator? Or, will the motor have to be compound-wound also?

How much more power will a 50-kw. generator deliver at 250 v. than one of like rating at 110 v.? V. H.

A. There will be no particular difficulty in operating your 120-v. lamps from 150-v. compound-wound generator, connecting two lamps in series, and you will, of course, be cutting down the transmission losses in the wiring. This will be much better than using a rheostat to reduce the voltage on the light line, as this rheostat would waste half the energy.

You can operate a series, shunt or compound-wound motor from the lines supplied by a compound-wound generator. Of course, you understand that the series-wound motor is not a constant speed machine, and should be used only where the load is practically steady. If the load decreases, the motor will speed up, and at very light loads is liable to run so fast as to be dangerous. Either the shunt motor or the compound-wound motor can be used without any difficulty.

There will be no difference in the power furnished from a 50-kw. machine, whether it generates at 110 or 250 v. Of course, the current from the 110-v. machine will have to be twice as great to give 50 kw. as from a 250-v. machine, and the armature windings and the field windings will have to be entirely different, but the amount of power supplied will be the same.

Criticism of Indicator Card

REFERRING to the indicator diagram submitted by A. G. E. and shown on page 425 of the May 15 issue, these would be considered by many engineers not bad cards; however, there is room for improvement by means of the following suggestions:

Assuming the card was taken from a single eccentric Corliss engine, it appears from the steam line shown on the diagram that the steam piping is too small for the piston speed corresponding to the 145 r.p.m. of the engine.

The inward leaning of the admission would indicate a tardy steam valve action. To bring these admission lines erect is a question of proper lead and to correct this would necessitate advancing the eccentric about 12 deg. It is desirable always to keep the lead as small as possible and yet maintain the admission lines perpendicular to the atmospheric line. Advancing the eccentric will also improve the compression, which now is in excess for economical running. If further adjustments of the compression lines are necessary they may be taken care of by adjusting the exhaust valve rods.

The drop in the steam lines is caused by the wire-drawn action of the steam supply or by the tardy action of the steam valves. F. E. BACON.

Boiling Temperature of Lard

REGARDING the inquiry of a reader appearing on page 425 of the May 15 issue of Power Plant Engineering, relative to the temperature at which lard boils, I wish to say that this temperature is 540 deg. F. at atmospheric pressure of 14.7 lb.

NATHAN HETLER.

DURING THE coming year the Society of Electrical Development will conduct a "Convenience Outlet" campaign similar to the "Wire Your Home" campaign, sending out broadsides, booklets and folders and asking the co-operation of local committees in educating people to appreciate the value of special outlets to which electric appliances may be connected.

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Change in Subscription Price

As already announced, the subscription price of POWER PLANT ENGINEERING is increased June 1.

Considering the rise in cost of all materials and in wages, this hardly needs explanation. Paper has practically doubled in price, wages and salaries have increased by 30 per cent, postage on letters has increased 50 per cent and rents likewise.

Increase in subscription price has been delayed as long as possible, but no business can continue with expenses greater than income; hence it has been necessary to make this change.

All present subscriptions will be filled to the date of expiration, but after June 1 the rate for a subscription, new or renewal, will be $1.50 a year, or $3 for two years.

Readers who have on hand letters or printed matter in which the former price is quoted, will please bear this in mind.

What to Read and How to Read It

As one passes from the elementary, generalizing stage of his engineering education and experience, he finds text books an aid chiefly as works of reference in pointing out general principles, and practices which may have become obsolete and are rarely less than a year behind in presenting the developments of the times. New books are revisions of old standard works with the addition of more recent developments that have proved themselves reliable. An authentic author would not think of putting in his book written for permanent use, information on developments which are in their experimental stage.

Books by standard authors upon subjects in which you are interested should be read and thoroughly digested. New works upon the same subject will undoubtedly contain information with which an experienced man is familiar, so in order to conserve time, new books should be carefully reviewed, points upon which the mind has become hazy should be studied again thoroughly, note should be taken of new tables and charts presented and all developments which are new to the reader should be examined with extreme care, comparing results of tests or features of design with the results of your own experience and apparatus with which you are familiar.

Bulletins from state experiment stations and government bureaus come next to text books in their value as reference works but go into more minute details in regard to methods employed for securing the data presented and for special subjects there can be no better source for obtaining authentic information. It must be realized, however, that to conduct extensive experiments, collect data and present it all in the shape of a bulletin takes considerable time, often extending over a period of years.

Proceedings of the various technical and professional societies come next in the order of furnishing information that is authentic and are usually more valuable than text books or experiment station bulletins in that the authors of the papers and those who discuss them are generally practical men in the industry and their deductions are from the viewpoint of one who has put his theories into practical, commercial use.

Technical magazines, properly edited, are works of reliable information collected from all sources available —text books, experiment station bulletins, technical societies, men of authority in the field. The very latest ideas in details of construction, arrangement, operation and management of machinery are found here. Frequently ideas are presented in advance of their application. The fine points of the industry are brought out more fully and completely in magazines than in any other printed form for the majority of contributors to magazines present in no other way many unique experiences which point the way to success or failure in the work of the reader.

Read a magazine as you should a new book, seeking new ideas which can be applied in your own work; read it without prejudice, then compare the author's statements with your own experiences; let no information which may be of value escape your notice. Tables and charts are wonderful economizers of time; save them and use them. Much extremely valuable data and information contained here will never be put into book form; this should be preserved for ready reference.

Many manufacturers publish catalogs describing apparatus of their manufacture, how it works and what care should be given to it. This source of information should not be overlooked in one's scheme for development.

Slipshod, indefinite, inattentive reading is worse than useless to an engineer, as it gets him into a bad habit, extremely hard to break.

Do You Know?

How to design and install a monorail conveyor system for handling your coal and ashes?

Whether or not your company is losing money by distributing power from the power plant switchboard rather than from a board located in the shop?

Why fibrous or porous matter makes a good insulation?

What condition should be considered in selecting pipe covering?

What percentage of the heat developed in your internal combustion engine is lost in radiation, jacket water and exhaust?

What system of utilizing waste heat from the gas engine is most feasible in your plant?

Whether your storage battery electrolyte is acid or alkaline?

How to keep the electrolyte at the proper density?

How to tell when an alkaline battery is fully charged?

What test to make for ammonia in brine tanks?

Whether brine will leak into ammonia or ammonia into brine in your brine cooler?

How to test for brine in ammonia?

The amount of money being wasted a year due to low percentage of CO_2 in your flue gases?

Why your compressed air lines freeze in winter?

What instruments to specify for your boiler room?

What three conditions are necessary to obtain high belt efficiency?

That you have read the contents of this issue sufficiently well to apply the principles pointed out, in your own plant?

Inspection and Classification of Power Plants

DEFINITE announcement comes from the U. S. Fuel Administration of a plan for inspecting power plants and classifying according to their economy. The administration estimates that, using present equipment, a saving of 10 to 20 per cent can be made in the fuel consumption, amounting to some 35,000,000 tons of coal a year in the plants of factories, office buildings, hotels and apartment buildings by careful attention to proper conditions for combustion and correct handling of fires. Existing committees and commercial and engineering societies will be asked to co-operate with the national program, which comprises the following fundamentals:

1. Personal inspection of every power plant in the country.

2. Classification and rating of every power plant, based upon the thoroughness with which owner of said plant conforms to recommendations.

3. Responsibility of rating the plants will fall upon an engineer in each district, the rating to be based upon reports of inspectors, who will not express opinions, but will collect definite information. The state fuel administrator, in his judgment, may entirely or partially shut off the consumption of coal to any needlessly wasteful plant in his territory.

4. Inspectors are to be furnished from one or more of the following sources: (a) Inspectors of the steam-boiler insurance companies; (b) state factory inspectors; (c) engineering students from technical colleges; (d) volunteers.

The ratings will be based upon recorded answers to questions, each of which will be given a value depending upon its relative importance to the other questions. Depending upon the efficiency of methods in use in any plant, it may be rated in class 1, 2, 3 or 4.

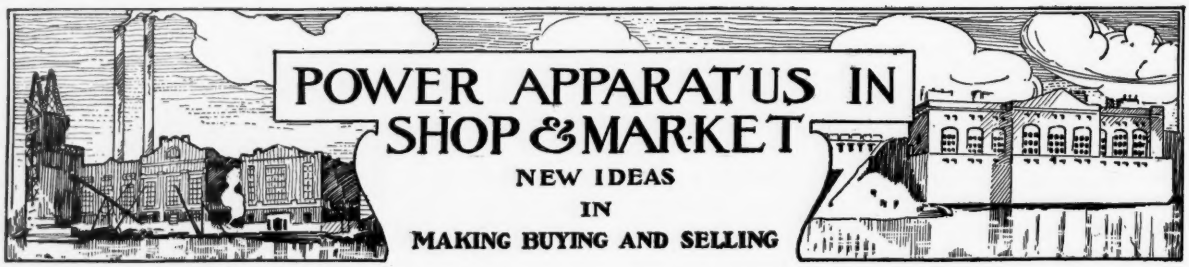
Ratings Figured on Present Equipment

Ratings will be based upon existing equipment. The difficulty, delay, and expense involved in the installation at this time of improved power equipment is fully recognized, but experience has proved that 10 to 20 per cent of fuel now used in power plants can be saved by improvement in operation alone.

In advance of the first inspection a questionnaire will be sent to every power plant in each district, with notice to the owner that within 60 or 90 days his plant will be inspected personally and the questionnaire will be checked up by the inspector upon his visit. This action will prepare plant owners for what will follow; will allow proper care in furnishing information, and will also permit improvement of plants, if necessary, so that they may be rated in a high class by the time the inspector calls.

It is recommended that a board of competent engineers be attached to the conservation committee in each state; also a corps of lecturers to arouse public interest and disseminate engineering information.

The administration is preparing a series of official bulletins on engineering phases of steam and fuel economics. Some of these are now ready for printing.



New Possibilities in Furnace Combustion

HERETOFORE, the shape of vertical passes in water-tube boilers has been determined by the fact that loose tile placed against flame plates were used for baffle walls. It was found that an effort to build an inclined wall to give the theoretically perfect pass resulted in the dislodgment of the tile under the vibration of the tubes, and any effort made to remedy this trouble of interlocking the tile introduced difficulty when partly retubing or completely rebaffling the boiler.

In fact, the replacement of the loose tile in any case is a difficult matter, as tile of the original size cannot be used without spreading the tube temporarily to insert the new tube, a practice to which many operating engineers object. As an alternative, smaller tile are used,

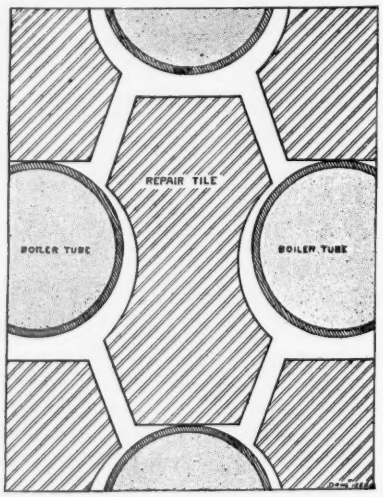


FIG. 1. SECTION SHOWING USE OF REPAIR TILE

but this necessarily results in open joints through which the hot gases short circuit. Their use in a forward sloping wall where they would be underneath the flame plates, which in the ordinary vertical or backward sloping baffle wall support them, presents many difficulties.

With the development of the Turner baffle wall, a new construction was introduced that has made some desirable changes practicable. This wall is built by introducing in the diagonal "alleys" between the tubes a molded, corrugated tile, dovetailed at the ends. The pockets thus formed by the tubes and the adjacent rows of tile are filled with a plastic material which, while completely filling the space, no matter how irregular, does not grip the tubes as it shrinks in hardening, but leaves a small annular space around them. The tube can be withdrawn when cold, although the filling cannot be displaced, as it bonds with the corrugations in the tile which dovetail at the ends with each other.

It has been found an advantage in boiler design to give the gases of combustion as near a uniform velocity through the passes as possible. A study of the curve showing the decrease in volume of these gases due to the cooling effect of the surfaces over which they pass,

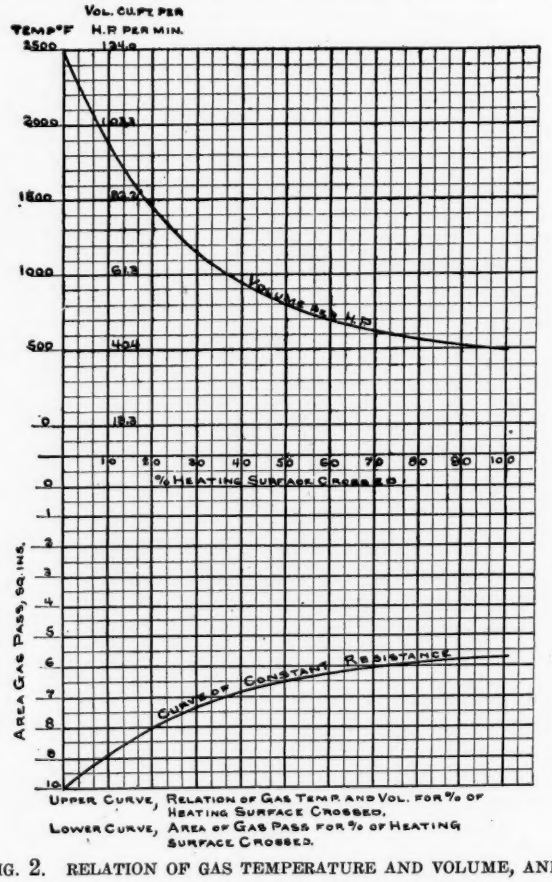


FIG. 2. RELATION OF GAS TEMPERATURE AND VOLUME, AND AREA OF GAS PASS FOR PER CENT OF HEATING SURFACE CROSSED

Fig. 2, shows that with 43 per cent of the heating surface in the first pass the area of its outlet should be about 68 per cent of the area at the bottom. As the cooling effect of the drum and the superheater when used are comparatively small, the area at the top of the second pass should be somewhat less than that at the top of the first pass and the second pass should also taper. The third pass shows little cooling effect, and its shape is not so material, as

long as ample space is provided for the exit of the gases.

The elevation of the boiler shown in Fig. 3 illustrates the application of these principles. The bridge wall was moved back to enlarge the furnace chamber, and to keep down the furnace temperature. By the location of the bridge wall the opening of the first pass was established. The Turner wall starts from the bridge wall and slopes forward at such an angle as to make the top area 68 per cent of the bottom, the heating surface exposed in the first pass being about 43 per cent of the total. The rear wall is carried down at right angles to the tubes, and it is a matter of judgment as to its slope and how far down to extend it. Some engineers claim it an advantage to contract the lower end of the second pass so as to increase the velocity of the gases at this point and direct them well down over the lower rows of tubes and toward the rear end of the boiler. The expansion of the gases on their release also helps to this end and the reduction in velocity due to the change from passage across the tubes to passage along the tubes as well as the mushrooming into the space back of the bridge wall

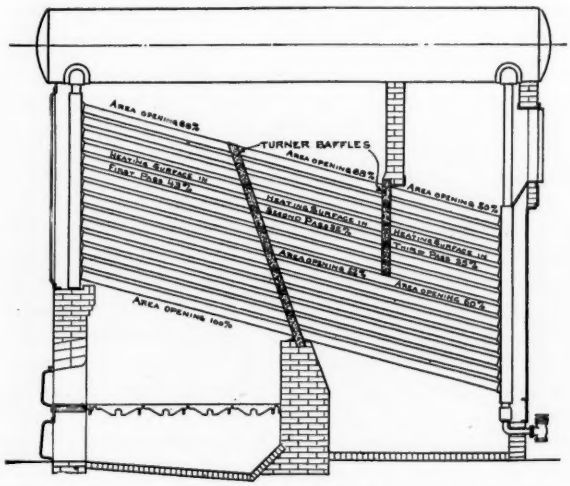


FIG. 3. METHOD OF APPLYING TURNER BAFFLES TO HORIZONTAL WATER TUBE BOILER

tends to drop into that space, any cinders or soot otherwise carried up the stack.

Advantages over the alternative use of a short section of horizontal baffle on the lower row of tubes running forward from the top of the bridgewall to the bottom of the ordinary baffle wall are evident. First, a larger tube surface is exposed in the first pass to the radiant heat of the fire and to the gases when hottest, tending to increase capacity and at the same time lower the furnace temperature, since the heat goes into the water instead of the setting.

Second, a flat surface and not an elbow with a joint impossible to keep tight with the inevitable expansion and contraction of the horizontal baffle, is presented to the flames. Third, the difficulty of renewing the lower tubes, which are most frequently burned out, is lessened as they carry no horizontal baffles. Fourth, there is no dead angle at the bottom of the second pass where the vertical and the horizontal baffles join. Fifth, there is no leakage, as there would be through the horizontal and transverse joints of the horizontal baffles.

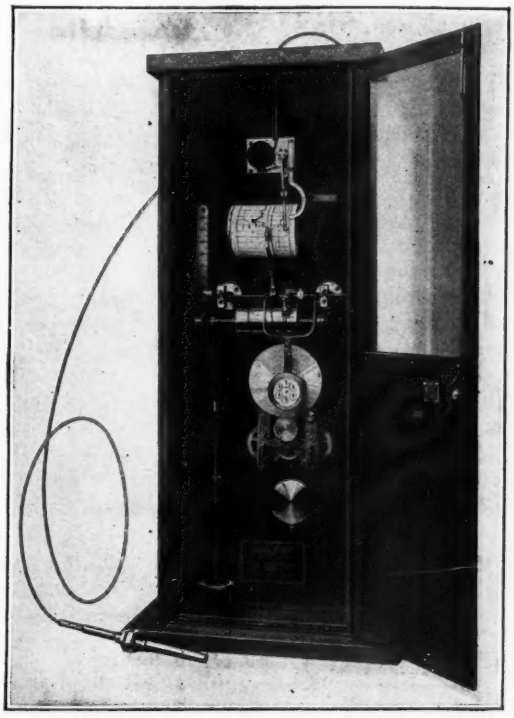
Another application of the sloping Turner wall is the downward extension of the rear baffle to lessen cinder carrying.

The wall has been perfected and its methods of construction developed by The Engineer Co., New York City.

Lea V-Notch Meter with Temperature Recorder

A RECENT development in connection with the Lea V-Notch Meter manufactured by the Yarnall-Waring Co., Philadelphia, Pa., is a temperature recorder which will record simultaneously and on the same chart, with the weight of the feed water, its temperature. In this way, the exact temperature of the feed water may be ascertained and recorded for future reference at any point during the 24 hr. and in exact relation to any changes in the character of the feed.

The outfit is furnished complete with 5-in. sensitive bulb, a separable ¾-in. connection and 10 ft. of flexible insulated tubing.



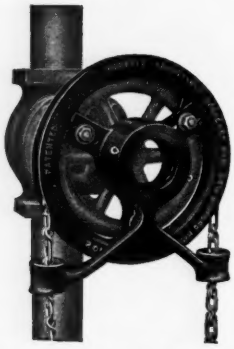
LEA V-NOTCH METER WITH TEMPERATURE RECORDER

In view, however, of the recent adoption by the Yarnall-Waring Co. of the trade name "Yarway" for all products manufactured by that company, the Lea V-Notch Recording Liquid Meter will in the future be known as the Yarway V-Notch Meter with Lea Recorder.

PETROLEUM, asphalt or tar products for the construction or maintenance of roads will be delivered only after approval of the application by a committee representing the U. S. Fuel Administration and the Office of Public Roads of the U. S. Dept. of Agriculture.

An Improved Rim for Chain-Operated Valves

EVER SINCE the Babbitt Adjustable Sprocket Rim came on the market there has been a decided increase in the number of overhead and inaccessible valves operated by chains. This device eliminates entirely the inconvenience of carrying heavy ladders and appeals strongly to engineers, since chain operation is much easier than the old-fashioned "ladder" method. In addition to this, the element of danger from the use of a ladder is no small one, and the last report of the Massachusetts Industrial Accident Board showed over 900 accidents due to falling ladders. In the engine room where the floors are frequently oiled, there is particular danger of the ladder slipping.



METHOD OF APPLYING BABBITT RIM TO CHAIN-OPERATED VALVE

A recent improvement on the Babbitt Rim is a chain guard consisting of two arms through which the chain passes. The arrangement can be clearly seen in the accompanying illustration. In any ordinary installation this guard, to prevent the chain from jumping off the wheel, is entirely unnecessary; but on board ship, or where the valve stem is not horizontal or where other unusual conditions exist, such a device is sometimes advisable. These rims are made by the Babbitt Steam Specialty Co., of New Bedford, Mass.

Skilled Men Wanted for U. S. Army Ordnance

AN urgent call for high grade technical men and operatives to fill war positions in industrial establishments was made recently through the Civil Service, by the United States Army Ordnance.

Salaries ranging from $1600 to $6000 a year will be paid the men who qualify for the places.

Chemists and chemical engineers, men experienced in the manufacture of gas, mechanical engineers on high pressure apparatus, engineers to take charge of power houses, and foremen of machine shops are needed. Persons of military age accepting appointment will not avoid the obligations of the Selective Service Law.

The Army Ordnance, in issuing its call for these men, is insisting on one point. No applications will be accepted from Government employes or employes of firms or corporations engaged in contracts for the Government or its Allies unless written assent to such application is given by the head of the establishment that might be seriously handicapped in its war work by the loss of the man.

Operatives in gas manufacture—men to operate and control the processes of production of water gas and producer gas—are urgently needed by the Ordnance Office. Applicants for these positions are paid $1600 to $2400 a year, and must have at least 5 yr. experience if high school graduates, or 10 yr. experience if their education has been a common school education.

Salaries ranging from $1600 to $2400 will be paid junior mechanical engineers on high pressure apparatus who wish to do their bit toward winning the war by working for the Ordnance Department. Experience in the operation and control of high pressure hydraulic and gas machinery is necessary. At least one year of such experience will be required of graduates in mechanical engineering courses from recognized colleges; 4 yr. experience is required of high school graduates.

Power house engineers will be paid $1800 to $2400 a year while working for the Ordnance Department. Supervision of operation of water-tube boilers, condensers, pumps, steam turbines, and alternating and direct current generators and motors are among the duties of these men. Machine shop foremen with salaries from $1800 to $2400 also are wanted by the Army Ordnance; 10 yr. experience as machinists, 3 yr. in a responsible supervisory capacity is required.

Assistant operatives in the manufacture of water gas and producer gas, mechanics experienced on high power apparatus, and operatives of acid and chemical apparatus are wanted by the Army Ordnance. Many positions are open. The needs of the service, the Ordnance Department announces, are so imperative that applications will be received indefinitely. Further information regarding the Army Ordnance positions that must be filled is obtainable of the Civilian Personnel Section, U. S. Army Ordnance, 1330 F St., Washington, D. C.

News Notes

FINAL REPORTS of the Liberty Loan campaign among employes of the Westinghouse Electric & Mfg. Co. and its subsidiaries show that the total subscription was $2,601,000. Of this, $2,217,000 was taken by employes of the parent company. Three subsidiaries showed 100 per cent of employes subscribing—the R. D. Nuttall Co., the Krantz Mfg. Co. and the Pittsburgh Meter Co. In addition to this, the Krantz employes subscribed the largest per cent of total payroll—10.4 per cent and the largest amount per subscriber, $87.27. Electric Co. employes to the number of 32,048 subscribed $69.18 per capita, 5.2 per cent of the payroll. All figures show a gratifying increase over those of the Second Loan, showing that Westinghouse men and women are solidly backing their 4000 fellow-workers now with the colors.

MANUFACTURERS OF MACHINERY and mechanical appliances will now have the advantage of a central location where all lines of machinery and mechanical appliances can be grouped together under one roof, in the Machinery Sales Department of the Grand Central Palace, New York, a department arranged for the permanent display and sale of all classes of machinery, tools and mechanical

appliances. Machinery can be shown in operation, if desired. This department will occupy an entire floor, having an area of 50,000 sq. ft. of floor space, the aim being to do everything possible to attract buyers to this permanent display and salesroom. For the convenience of the buyer, a general information bureau and reading room will be maintained where important trade and technical journals and catalogs will be kept on file.

All communications addressed to the Machinery Sales Department, Grand Central Palace, New York City, will receive prompt attention and detailed information as to space, rates, floor plans, etc., will be cheerfully furnished.

THE SPRAGUE ELECTRIC WORKS of General Electric Co., reports that on May 1, 1918, every employe (1482 men and women) subscribed to the Third Liberty Loan. These subscriptions aggregate the sum of $116,850, or an average subscription of $78.85 from each employe.

BOUND BROOK OIL-LESS BEARING CO., Bound Brook, N. J., announces that on May 15, 1918, its western office was moved to Room 1723 Ford Bldg., Detroit, Mich. It was formerly located at 308 Boffat Bldg. This office is in charge of Harry J. Lindsley, western sales manager.

AT THE MEETING of stockholders of Joseph Dixon Crucible Co., recently held, the following were elected directors: Geo. T. Smith, Wm. G. Bumsted, J. H. Schermerhorn, Geo. E. Long, Edward L. Young, Harry Dailey and Robt. E. Jennings, and officers were chosen as follows: Geo. T. Smith, president; Geo. E. Long, vice-president; J. H. Schermerhorn, vice-president; Harry Dailey, secretary; Wm. Koester, treasurer; Albert Norris, assistant secretary and assistant treasurer.

For the American Graphite Co., which is a subsidiary of the Joseph Dixon Crucible Co., the same directors and officers were elected, with the exception that J. H. Schermerhorn is treasurer of the American Graphite Co.

ANNOUNCEMENT is made of change in address of the Crane Packing Co.'s New York City office to larger quarters in the Park Row Building and the appointment of Julian N. Walton, manager. A. W. Payne, connected for some time as manager of this district, has been made sales manager of the United States and Canada, with headquarters at the home office in Chicago. The Pittsburgh offices are located in the May Building, Pittsburgh, the Philadelphia office in the Colonial Trust Building.

THE HOUSTON OFFICE of H. W. Johns-Manville Co. will be located at 424-426 Washington Ave., Houston, Texas, on and after July 1, 1918.

AT THE National Co-operative Convention of the American Association of Engineers, meeting jointly with the Committee on Engineering Co-operation and with delegates from national, state and local engineering societies in Chicago, May 14, more than 50 different societies were represented by delegates.

The association's officers elected for the coming year are: President, W. H. Finley, chief engineer, C. & N. W. Ry.; first vice-president, W. H. Clausen, assistant City Engineer of Chicago; second vice-president, L. K. Sherman, president L. K. Sherman Engineering Co.; national directors to serve two years, Harold Almert, consulting engineer, Chicago; F. K. Bennett, principal assistant engineer, M. & St. L. R. R., Minneapolis, Minn.; T. M. Chapman, civil engineer, Central of Georgia Ry., Savannah; J. N. Hatch, consulting engineer, Chicago; Alexander Potter, consulting engineer, New York City; J. H. Prior, consulting engineer, Chicago.

The society service of the association was extended by the convention in the form of an amendment to the national bylaws authorizing the directors to grant certificates to three or more members, who may petition to form an A. A. E. Club in any city or community of the United States.

Reports of the national officers showed membership growth for the past year slightly exceeding 1200 and the average net membership growth at the present time of 125 per month.

Two different plans for co-ordinating society activities created an interesting debate, which was settled by authorizing the American Association of Engineers to appoint from the conference a committee of five and send a request to the Engineering Council that they appoint a committee of five to meet the first committee and try to work out a solution for future activities.

The convention generally approved uniform legislation for licensing engineers, expressed a desire for more publicity to be given the profession, and unanimously adopted resolutions in favor of universal training.

Results of the questionnaire returned from 65 societies indicated that 15 per cent of all engineers are in active military service, that 10 per cent still desire to enter military service, that about 50 per cent can be secured for emergency government work. The general opinion is that the status of the American engineer will be better after the war. Only two societies reported that they are organized at present so as to give systematic service in securing employment for engineers who return from the war. Other societies express a willingness to do all they can.

It is commonly expressed that individual efficiency of technical men can be raised by better education, greater individual concentration and application through united society service, by taking more active part in public life and in earnest co-operation between one engineer and another.

The sentiment expressed by all societies is that the technical profession is paid from 50 to 75 per cent too low, that the compensation is not in proportion to the duties and cannot be compared with that of other classes of professional men. The societies generally favor licensing engineers, especially if license laws are made uniform by federal action and if the laws are carried out so as to protect the profession and the public.

Trade Notes

AT THE Sixth National Textile Exposition in Grand Central Palace, New York, an interesting display of devices was held, including all kinds of machinery used in textile mills. Among those of interest to power

plant men were the following: The American Pulley Co., Philadelphia, Pa.; American Steam Gauge & Valve Mfg. Co., Boston, Mass.; American Tool & Machine Co., Boston, Mass.; Borne, Scrymser Co., New York City; The Carlyle-Johnson Machine Co., Manchester, Conn.; Carrier Engineering Corp., New York City; Cling-Surface Co., Buffalo, N. Y.; Coppus Engineering & Equipment Co., Worcester, Mass.; Fairbanks Co., New York City; General Electric Co., Schenectady, N. Y.; General Fire Extinguisher Co., Providence, R. I.; Graton & Knight Mfg. Co., Worcester, Mass.; Jefferson Union Co., Lexington, Mass.; Keystone Lubricating Co., Philadelphia, Pa.; Lead Lined Iron Pipe Co., Wakefield, Mass.; Link Belt Co., Nicetown, Philadelphia, Pa.; Morse Chain Co., Ithaca, N. Y.; Frank Mossberg Co., Attleboro, Mass.; National Flue Cleaner Co., Inc., Trenton, N. J.; New York & New Jersey Lubricant Co., New York City; Norma Company of America, New York City; Patterson-Gottfried & Hunter Co., New York City; The Permutit Co., New York City; Pratt & Cady Co., Inc., Hartford, Conn.; The Reeves Pulley Co., Columbus, Ind.; S. K. F. Ball Bearing Co., Hartford, Conn.; L. Sonneborn Sons, Inc., New York City; Swan & Finch, New York City; C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.; W. O. & M. W. Talcott, Providence, R. I.; Templeton Mfg. Co., Cambridge, Mass.; Tillotson Humidifier Co., Providence, R. I.; The Transmission Ball Bearing Co., Inc., Buffalo, N. Y.; U. S. Gutta Percha Paint Co., Providence, R. I.; Veeder Mfg. Co., Hartford, Conn.; Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

GAGE GLASSES "made in America" will be the result of the establishment of the plant of the Arkansas Glass Products Co. at Van Buren, Ark. George L. Hammons, president of George L. Hammons, Inc., of Chicago, is first vice-president of the Arkansas company and will have a large interest in the manufacture as well as the sale of the Ozark and Duraco Gage Glasses for the manufacture of which the plant was erected.

This plant was located at Van Buren, because, after long search it was there that the particular grade of sand needed to make a high grade glass was found. The most modern equipment has been provided, including a special furnace and the work will be done under the supervision of experts who have gained their knowledge in foreign plants.

Thus is one more American product assured to take the place of those heretofore imported and to aid in rendering us independent of European sources of supply. Tests of these glasses extending over months in laboratory and power plants have proved them equal or superior to the foreign glasses, as stated by those who have made the tests.

GREENE, TWEED & CO., 109 Duane St., New York, has recently received from its agents in England, Jenkins Bros., Ltd., an order for 10 half-pint, 10 one-pint, 50 two-pint single-feed clutch drive Rochester automatic lubricators and 2 two-pint double-feed Rochesters; a total of 72.

AT THE textile show, Lewis E. Tracy Co., of Boston, exhibited a line of power transmitting machinery including pillow blocks, hangers, pedestals, post hangers, collars and couplings; also a line of the Crescent belt fasteners, made by the Crescent Belt Fastener Co.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

(Established over 22 years.)

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

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Front cover, $240.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Three line parallel 3-point border rule used.

Stippled plates used, but no heavy, black and white plates.

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Per line, 30 cents each insertion.

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Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy and cuts should be received at Chicago Office eighteen days prior to date of publication.

Circulation of this issue, 23,700.

Technical Publishing Company

537 S. Dearborn Street,

Chicago

Position Wanted

POSITION WANTED—By master mechanic familiar with gas and steam engines, boilers and electrical machinery; capable of taking complete charge of mechanical end of large factory; 17 yrs'. experience. Age 37 yrs. Sober and in perfect health. At present employed as master mechanic of factory. Desires change on account of not liking the East and will consider only the West. Address Box 523, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 5-15-1

POSITION WANTED—As engineer in small plant; 10 yrs'. experience with Corliss and high speed engines. Familiar with d.c. generators and gasoline engines. Age 34. Married. Strictly sober and good repair man. Address F. H. Daton, 2823 Calumet Ave., Chicago, Ill. 5-15-1

POSITION WANTED—As chief engineer, 13 years' experience with Corliss and high-speed engines, electrical and refrigerating machinery. Sober and reliable. Best of references. Address Box 518, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-1-2

POSITION WANTED—To take charge of plant as superintendent. A1 electrician. Salary $150. For further particulars write Box 520, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 5-15-1

POSITION WANTED—By a first class man, aged 35, married, strictly sober, reliable and energetic. For the past 7 years superintendent of water, light and power plants, capable of doing any kind of work in steam or electrical engineering, meter repairing or testing, line work or inside wiring. Especially capable of managing water and light plant properties. Prefer a field where there is a chance of advancement. Address Box 522, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 5-1-2

POSITION WANTED—As oiler or assistant engineer in a power plant around New York City; 1 yr. experience as student and assistant to engineer. A. J. Benora, 38 Park Hill Ave., Yonkers, N. Y. 5-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, O.; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineer, 537 S. Dearborn St., Chicago, Ill. tf

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

WANTED—A competent electric light engineer, familiar with Corliss engines, 12-hour shift. Good working conditions. Salary $85.00. Fuel consumption 2½ tons per shift. No boiler washing. Address L. F. Haupt, superintendent, Prairie du Chien, Wis. tf

WANTED—Motor-driven ice machine, 50 to 80 tons. State make, price, etc. A. Fink & Sons, Newark, N. J. 5-15-2

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial to put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, O. tf

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf

WANTED—Engineers in their spare time and salesmen who carry side lines and visit engineers to sell the Selden and Zena packings. Both packings have shown their worth by use in largest plants. Randolph Brandt, 70 Cortlandt St., New York. 3-15-6

WANTED—For low vein mine, 3½ to 4-ton electric locomotive. The Federal Clay Product Company, Mineral City, Ohio. 6-1-1

For Sale

FOR SALE—Boilers: 305 hp. and one 225-hp. Heine water tube boilers, in battery, 175 lbs. Hartford insurance. With stokers. Practically new; installed 1912, 2 yrs'. service, $10,000. Power Machinery Exchange, Jersey City, N. J. tf.

FOR SALE—Boilers, two 300 hp. Freeman internal fired, 125 lbs. pressure. Fixture complete. Immediate shipment. Make us a price. Mitchell Motors Co., Inc., Racine, Wis. 5-15-2

FOR SALE

1—12 x 8 x 10 Worthington Duplex

STEAM PUMP

rebuilt and guaranteed; 6-in. Suction, 5-in. Discharge; equipped with Hill valve and seats on discharge side.

Ready for Immediate Shipment

Western Felt Works
4115 Ogden Ave., Chicago, Ill.

BOILERS

2nd Hand—All Sizes and Makes

For Immediate Shipment

J. F. DAVIS, 1407 Harris Trust Bldg, CHICAGO, ILL.

FOR SALE

Feed Water Heater and Receiver

Cochrane horizontal cylindrical, capacity to heat 30,000 lb. of water per hour, withstand back pressure 15 lb. per sq. in. Practically new. May be seen in operation at

Manhattan Refrigerating Company
West and Horatio Streets, New York

FOR SALE

AIR COMPRESSOR

Laidlow feather valve 10-18 x 12 x 14 cross compound, steam driven, duplex single-stage. Practically new. May be seen in operation at

Union Terminal Cold Storage
Twelfth, Thirteenth and Provost Streets,
JERSEY CITY, N. J.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent lawyer, 624 F St., N. W., Washington, D. C. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

FACTORY MANAGERS, ENGINEERS AND OWNERS—Coal is high and scarce. Let us tell you how to conserve it and utilize your exhaust steam for heating and drying purposes. Address Monash Engineering Co., 1413 W. Jackson Boulevard, Chicago, Ill. tf

Sparks From The Advertising Pages

Where Buyers and Sellers Meet

They Tread the Path of Glory

It is a Sunday evening in May. Three maidens stroll along the leafy street.

One left an office to help her father on his truck farm—the brother has gone; another left college and gives her time to Red Cross work; the third is earning a living for her widowed mother.

A year ago these maidens strolled this street—but not together. Three couples strolled then. . . .

It is a Monday morning in May. The early car leaves the station—the first one out. A graybeard gets on, his dinner pail strapped over his shoulder to give one hand free action with his cane, while the other gropes for support. Nearly every ruddy face is gray-fringed—except those of the score of women on their way to the factories.

A year ago this car was crowded with a husky, noisy, rough-and-ready lot of youngsters, scrambling for seats and chaffering of dances and baseball.

Rarely then did one see a woman here. . . .

As a Sunday night in May settles down in drizzling blackness, a battery detrains into the mud of France. Bugles sound and the column moves forward, straight toward that distant glare of war which makes the darkness visible.

Commiserate their lot? Never, for every man is tingling to the thrill of the great adventure. As one man says, "A man knows no keener joy in the world than I have tonight as we're rolling to the front to kick a dent in history."

On the Monday morning in May that battery wheeled into action as the sun rolled the gray mists away.

Youth—sublime youth—has set its feet in the path of glory.

Women, old men and boys are abandoning rocking chairs and the ball diamond on the patch to keep the wheels of industry turning.

Who will, who can, who dares fail of his part?

Who will fail to eliminate every task that will release men to follow those in France, or to adapt the necessary tasks to the strength of those weaker shoulders which now must bear them?

Who will send workers to oil bearings, or to shovel coal, or wheel ashes, when these tasks may be done better and cheaper mechanically?

Or who will send men to the mines to dig coal to be wasted for want of apparatus to save it?

Look over **your** power plant. This summer is the time to eliminate or lighten every task that machinery may better perform.

Look over the advertising pages of POWER PLANT ENGINEERING. Here is the tried, tested, proved equipment, supplies and tools of the power plant that save fuel, save supplies, save labor and guard the life and limb of these new workers whose hands must take up the tasks of those who fight for liberty.